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# THE AMERICAN GAS LIGHT JOURNAL

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**Correspondence.**—Wishing to make this JOURNAL a gazette of intelligent discussion to those of our readers who may wish to gain or give information on the subjects to which its columns are devoted, correspondence is solicited for publication from all who make the study of those subjects a pleasure or a profession.


*The Public Lighting Tables of the American Meter Company will be found in the page advertisement of that Company.*

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[OFFICIAL NOTICE.]

### November Meeting, Society of Gas Lighting.

OFFICE OF THE SECRETARY, November 1st, 1894.

The next meeting of the Society of Gas Lighting will be held in The Arena, 31st street, east of Broadway, New York City, at 3 P.M., November 8th.

FRED. S. BENSON, Secretary.

[OFFICIAL NOTICE.]

### November Meeting of the Guild of Gas Managers.

OFFICE OF THE SECRETARY, October 26th, 1894.

The November meeting of the Guild of Gas Managers will be held in Young's Hotel, Boston, at noon of Saturday, November 10th.

A. K. QUINN, Secretary.

## BRIEFLY TOLD.

THE STATE OF TRADE.—Since our last reference to the state of trade (see JOURNAL, September 17th), the returns from our selected test points all go to show that the improvement then reported as manifesting itself has continued; not only so, but that the increase in output is fast approaching the normal. This is particularly so in respect of the large centers, and perhaps the city of New York affords the most notable example, for here the increase is little short of remarkable. It is true that the month just closed, especially referring to the last fortnight, was one marked by atmospheric conditions that delight the gas maker, in that dull, rainy days were frequent; but, on the other hand, September was unusually bright and clear, so we may fairly claim that the atmospheric conditions prevalent for September and October as a whole constituted a fair average of the usual order. Our returns are from 22 points, out of which only one reports a decrease (amounting to 5.9 per cent.), the general average increase amounting to 6.4 per cent.—of course, it is understood that the figures refer to the sendout of September and October of this year as against the corresponding months of 1893. The tone of the responses of the gentlemen who have so kindly responded to our inquiries is all to the sound of brisker times; and we are positive enough of our ground to assert that the returns for November and December, when made up, will not only show an increase over the corresponding months of 1893, but will reveal a gain over the same months for 1892.

THE PAPERS BY MESSRS. EGNER AND EVANS.—In our synopsis in this issue of the Proceedings of the American Gas Light Association, we print two papers, the first of which was read by Mr. Egner, who gave to the members a summary of his observations on sundry methods of making water gas from bituminous coal. As is usual with Mr. Egner, he put together a very interesting chapter, and as is also the rule with that which he writes, the subject matter provoked an animated discussion. Unfortunately, however, the discussion at one time assumed a direction that was not of his pointing, since it looked towards the exposition of the merits of processes in particular rather than to the expounding of the value in general of the system of making water gas

from bituminous coal, or from its coked residue. However, personal interest is a moving factor in the framing of a lively discussion, and those who listened to the debate on the Egner paper, as well as those who participated in it, had a half hour or so that could not be called other than lively. Mr. Egner's table of results, in which 11 different references to different processes are contained, even though it does report effects obtained from systems of water gas manufacture in which bituminous coal was not a factor, is sure to be often referred to. Nor does it show us that any of the examples given are remarkable for that superior fuel economy which it is often said is obtained by the fortunate operators of some water gas plants. For instance, we do not find him reporting any use of a less weight of anthracite than 40.2 lbs. in the generator per 1,000 cubic feet of gas made, although it is admitted that in that instance the work of the generators was intermittent—how "intermittent" we are left to think out for ourselves. However, intermittent or not, the weight named is far in excess of some claims we have heard made, when it was boldly asserted that 26 lbs. of anthracite were all sufficient. Take it all-in-all, we imagine that Mr. Addick's contribution to the discussion is pretty near to the meat of the matter; for, on an annual make of 930,000,000 cubic feet, using the Flannery system, the result was the taking up of 34.55 lbs. of coal in the generators per 1,000, and the using of 12.61 lbs. of other fuel for steaming purposes, and so on. Even admitting that the Flannery apparatus is not the most economical type of water gas generating plant, we think it will hardly hold to the claim that it is 8.55 lbs. in fuel per 1,000 inferior to any other system on the market. Mr. Evan's paper on "Petroleum: Its Products and Their Relation to the Gas Industry" is in that gentleman's best vein, and will also be frequently referred to for its statistical matter, for its second table is a gem of compilation, representing as it does the labor of many hours. We must, however, remain somewhat skeptical as to his valuation of Ohio gas naptha, until we have more specific data respecting the manner and methods pursued in making the tests.

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THE November meeting of the Guild of Gas Managers will, we understand, be marked by a visit of inspection to the works of the Waltham (Mass.) Gas Company, where a plant of the Kendall type has been installed.

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# Correspondence

[The JOURNAL is not responsible for the opinions expressed by correspondents.]

### Association Meetings and Advertising.

NEW YORK, October 31st, 1894.

To the Editor AMERICAN GAS LIGHT JOURNAL:

Is the writer not correct in supposing that the object of the annual meetings of the American Gas Light Association is the mutual exchange of knowledge with a view to the general good?

As no one man knows everything about gas and the work necessary to make and distribute it at all times, in all places, and under all circumstances and conditions, it has been deemed wise to gather together once a year experienced men from all parts of the land, to discuss those questions which are of first importance in the gas industry, to hear what difficulties have been met and how disposed of since last meeting.

If this understanding of the situation is correct, a great deal has been done at the annual meeting just held in Washington to lower the tone, and bring to sharp criticism this national council of the fraternity of gas engineers.

Though it is now too late to undo all the mischief, your correspondent would raise his voice against any future use of the council halls of the Association for airing personal grievances and advertising purposes.

The writer is not inclined to believe that it was the intention of any member to give so much prominence to purely personal business matters at that meeting; but that speeches were prepared in answer to a paper which was *expected* to attack various patented gas making processes, cannot be doubted; and such speeches, and the discussions raised by them, took up so much time as to crowd out entirely the reading of interesting papers, and discussions which no doubt would prove valuable.

The keen eye to business and frugality displayed in seizing such an opportunity to obtain free advertising cannot be doubted; but such *assurance* is too colossal to be incorporated with, or given room in the same hall with, the free-general-exchange-of-valuable-information idea. Yours truly, A. M. SUTHERLAND.

[Continued from page 621.]

## ABSTRACT OF THE PROCEEDINGS OF THE TWENTY-SECOND ANNUAL MEETING OF THE AMERICAN GAS LIGHT ASSOCIATION.

HELD AT BUILDERS' EXCHANGE HALL, WASHINGTON, D. C., OCTOBER 17 AND 18, 1894.

SECOND DAY—MORNING SESSION—Thursday, October 18.

The Association was called to order at 10 o'clock, A.M., and Mr. Egner was introduced to read his paper, with its supplement, which he did after stating that, as some exceptions had been taken to some points touched upon by it he wished to explain that one of the processes mentioned was at the time mentioned in the paper, still in its experimental stage, and the matter given by him was based upon information given him partly by the Superintendent of the works, but that the process had since been developed into something quite different that produced far better results.

The coal given in the paper was per thousand of fuel gas; but per thousand of commercial gas it would have been much less.

### OBSERVATIONS ON SUNDRY METHODS OF MAKING WATER GAS FROM BITUMINOUS COAL.

Water gas, in its practical form, generally but little understood; its advantages not comprehended; its progress strenuously opposed by those highest in authority in the gas business twenty years ago, has made such rapid strides in professional, individual and corporate favor, the past decade, that the first condition has now completely changed; and hence the writer in presenting this paper is confronted with the knowledge that he cannot hope for originality with any portion of his subject. Let us trust, however, that the facts to be placed before you may lead to such an interchange of experiences that, as it sometimes happens, these shall be of sufficient practical value to recompense us for the time given to the reading of this composition, and thus, in a measure, make up for its deficiencies.

The genesis of water gas, which briefly stated, consists in bringing carbonaceous material to an incandescent condition, then passing steam through the mass, thereby decomposing both; afterwards carbureting or not, the gas thus produced, has some time ago entered that stage, when the subject would no longer be interesting to an up-to-date audience of gas engineers; but in our daily practice are often developed peculiarities, the sum of the knowledge of which we define as "Experience." And proportionably, as we may be endowed with that desirable quality, which largely, though not by any means wholly, makes up the science of the gas engineer, we are enabled to overcome difficulties continually arising. But no one may be so fortunate, or the reverse, as to have fall to his lot a complete personal acquaintance with *all* the possibilities to be encountered in the pursuit of our professional duties; hence we gather at these annual conventions, freely exchanging experiences, with result admitted, that the various Gas Association meetings of the past have had a decided beneficial influence, not only upon the persons in attendance, the readers of the published proceedings, but also upon the gas and kindred industries at large. Pardon this digression, which is, in a sense, intended as my apology for having ventured to accept our Secretary's invitation to write a paper for this occasion.

In the early days of water gas one of the objections urged against it was that bituminous coal could not be employed in its manufacture. Even retort house coke was pronounced by supposed good authorities to be altogether unsuitable for the purpose. In those days it happened, once upon a time, that a prominent and high-ranking gas engineer sent a then young gas man, incognito, to the works of the company employing the author, to learn if it was true, and if so, how we were using coke in the making of water gas, since he without trial had declared it could not be done.

But it *was* done; and now we know that good retort house coke, weight for weight, is better than anthracite coal for that purpose, and it is only a matter of cost *which* should be used. And so it is used at a number of works, and was soon after the incident related, even at those managed by the "Doubting Thomas" referred to, who, by the way, has years ago passed over "to the silent majority," respected and regretted by all who had the good fortune to have the honor of his acquaintance. The supposed impossibility to employ bituminous coal directly in the manufacture of water gas, naturally stimulated invention. The writer himself caught the fever, so to speak, and designed an apparatus by means of which all kinds of gas coals were quite successfully

used to make water gas in a cupola generator. But in the end, at the suggestion of the president of the company—himself a gas engineer of acknowledged ability, and a Past President of this Association—the coal was first converted into coke in the good old way, and the latter used in the water gas apparatus. The average results of one year, during which the writer was connected with that company, and when 88,987,000 cubic feet of 20.87 candle power water gas were made, were as follows: Used per 1,000 cubic feet of gas made, 30.19 lbs. of retort house coke; 3.51 gallons of Lima crude oil, and 75-100 of one gallon of 63 degree gas naphtha, and made per man, 87,585 cubic feet per day.

Heating the apparatus was done by drawing the air up through the fuel, and it was so arranged that drawing up or down, or running steam to make gas—up or down—could be indulged in. Quite a number of patents for apparatus and processes for making illuminating water gas from or by aid of bituminous coal direct, were issued; a few of which only have survived, or ever even reached a practical test. Several methods are now in operation; and if, in the following necessarily brief description, the author shall succeed to shed additional light upon these—not too well known methods—and enable some of you to arrive at a closer conception as to what may be expected from them, he may, perhaps, after all be excused for writing this paper, and bringing the matter before you. The following which comprises the principal features, and the work done, is herewith respectfully submitted.

Within the past two years an advertisement could be seen in some of our technical journals, from which the following is an extract:

"The only successful process for making water gas from bituminous slack."

"A plant in actual operation since July 28, 1892."

"Only 3 gallons of crude oil required for carbureting, to produce 24 c. p. gas." (How much 24 c. p. gas?—F. E.)

"No condensation in pipes."

While knowing that a portion of this claim was absolutely without foundation in fact, and willing to believe that it was made in ignorance of the truth on the part of the advertisers, though that seemed barely possible, the whole matter seemed to invite honest investigation; and hence a little over a year ago, at date of writing, at considerable personal expense and inconvenience, the works where all this was claimed to be done was quietly visited. The cold facts found were, that the plant was scarcely even in an experimental stage, unless it be so regarded by reason of the superintendent's trying to operate the apparatus like the old Lowe water gas machines were run, and with anthracite, not bituminous slack, or any other kind of bituminous coal.

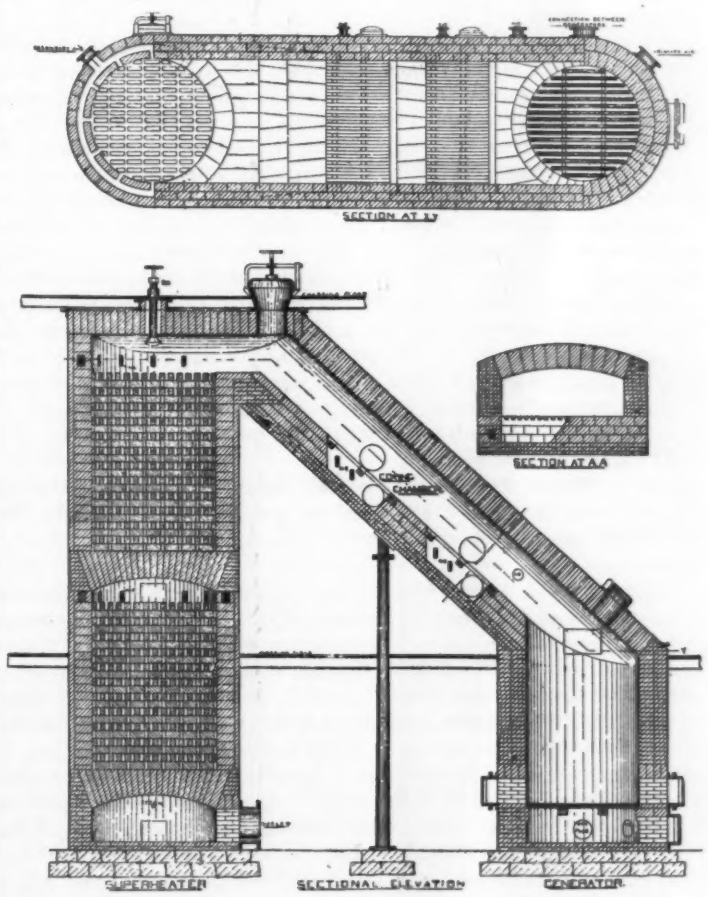
According to a reiterated statement of the general manager of the promoting company who had the patents to sell, 75.41 lbs. of coal and 2.99 gallons of oil were required to produce 1,000 cubic feet of gas of an undefined candle power, but say as the advertisement put it, 24-candle power gas. How much per man employed could be made could not be learned. But the superintendent in charge stated that if the gas was left over night in the small holder, into which it was delivered so hot that, while gas was made, one could not bear their bare hands upon it, it would shrink 40 per cent. The results claimed were calculated before the shrinkage took place. The gas was not metered at all at the works, excepting by the lift of the small holder referred to. Such was the statement made to me, and which seemed to be borne out by what was seen on that visit.

The apparatus consisted of 5 cylindrical, vertical shells, from about 6 to 5 feet in diameter, as near as could be judged. These cylinders, of boiler iron lined with firebrick, were standing in a row and at the top were connected with a horizontal, cylindrical shell, of apparently the same dimensions. There were fire doors, poke holes, steam and blast valves, distributed all over this apparatus, no doubt, where it was found to be most suitable, and on top were several hoppers through which the coal was to be charged when required. The device looked rather too complicated for good work, and such indeed the superintendent in charge said it was, and that that was one reason why he was trying to change it into a Lowe apparatus. Please bear in mind, however, that it is more than a year since the plant described was visited by the writer, and it may have been greatly improved during that time. Let us hope that the inventor has, or may yet, succeed in reaching that perfection with his apparatus, to which, no doubt, he honestly aspired.

But there is a lesson in all this short history, which those who are, or wish to be, interested in the gas business, would do well to ponder.

During the 21st annual meeting of this Association, those who were at Chicago may recollect the reading of an invitation to visit the works of the Cicero Gas Company, where a new process of much promise was said to be in operation. The Columbian Exposition proved the strongest attraction for the visiting gas man, and only three members of the Association, the officers of the Cicero Gas Company excepted, availed themselves of this opportunity. We found the works in fairly good order, though not yet complete in all its details, but through the courtesy of the superintendent of the works, the engineer of the Company and the genial inventor and adapter of the process, who were there in person to explain everything that could be desired, a fairly good insight into the practical working of the apparatus was had. The present output of the Company is much less than the capacity of the works, and it appeared difficult for that reason to obtain the exact producing power of the plant. The novel portion of the plant consisted in the gas generators, which were designed with especial view to using bituminous coals in the production of illuminating water gas.

Youghiogheny gas coal and Du Quoin nut, which is a good variety of steam coal, have been used, also others, all with satisfactory results. As enriching material, crude oil was employed for everyday work. The duplicate apparatus at the works mentioned occupied a floor space of




32 feet by 45 feet, and required three men on each shift to operate it and make the gas up to inlet of purifiers. The producing capacity averages easily 400,000 cubic feet in 24 hours for the pair, although if the output warranted continuous working it is believed, and can be readily understood, that the results in every way would be better than can be now reported. The apparatus is intended to be worked in duplicate, as then it is at its best, but it is not impracticable to operate them singly. The sets forming the duplicate apparatus are connected below the bottom grate at the base of the generators by means of a large valved pipe, the object of which is that gas made in a downward run of one set may be passed upwards through the heated material in the other, thereby insuring thorough and useful decomposition of all steam, oil and tar vapors, which may not have been sufficiently acted upon in the first set. A single set consists of a vertical, cylindrical generator, 7 feet outside and 4 feet inside diameter and 11 feet 6 inches high, one inclined chamber or internally fired retort 22 feet long, 7 feet diameter, and one fixing chamber 7 feet diameter and 30 feet high. The retort is D-shape inside, and 30 inches by 54 inches in section. It has two fire boxes with independent though internal grates forming part of it.

The lower end is joined to the generator and the upper one to the fixing chamber. Coal fed in at the upper end is gradually coked and reaches the generator as coke. Air blast pipes are connected to bottom of generator, fire boxes of retort and fixing chamber. The course of products of combustion and gas is downward through the fixing chamber, and is assisted in the first instance by both a blower and exhauster,

and when gas is made, by an exhauster only. Having seen the process in full operation, we cannot doubt that by means of this apparatus bituminous coal can be utilized direct in the production of illuminating water gas, with entire satisfaction. The results of several special tests made were reported to be as follows :

Using Youghiogheny coal, 4.31 gallons of oil and 36 pounds of said coal produced 1,000 cubic feet of 26-candle power gas. The same quality and quantity of gas required 4.66 gallons of oil and 48 pounds of coal, when Du Quoin nut was used. Gas making runs average 8 minutes ; blowing up or heating, 6 to 8 minutes. The fires are cleaned once in 12 hours. Fuel used under boilers, to make steam, is not included in that reported, but it is assumed that about as much would be required for that purpose as with the ordinary anthracite water gas generators.

The method adopted for making water gas, by one of the larger companies near New York City, is well worth considering, for although anthracite coal or coke can be used with very good results, it is, at the same time, one of the successful methods for employing soft coal direct, in making water gas.

Neither can the process be regarded in the light of an experiment any longer, for not less than 600,000,000 cubic feet of non-carbureted gas has been made in the manner about to be described, at these works since they were first started, and a very efficient coal gas plant owned by the company, has been "let down," the water gas plant furnishing all the gas required at this date. The first two sets of this apparatus were put at work early in November, 1891, and within two years six sets have been added to the original two. The conclusion must be that the company is satisfied with the process. These "sets" consist each of a water gas generator, hydraulic seal and a multitubular condenser, which by means of the heat recovered from the passing gas furnishes from 50 to 75 per cent. of the steam used at the works. Besides these primary condensers, there are the usual scrubbers and condensers in another building, the same as in any ordinary gas works. In this process no air blast is employed. Instead of that the heating up is accomplished by drawing air down through the fuel in the generators, which are supplied with a firebrick grate.

During the process of heating up, the generators are open at the top, and when making gas these openings are, of course, closed. The "runs" are made in about the same time as in the well known "Lowe" process.

But no one who has not been there to see for himself, can appreciate the quietness of the whole operation. There is no whizz and bang, flame and smoke as in most of the cupola water gas apparatus. Unless looking on, one would not know that gas was being made ; or in other words, that the apparatus was in operation at all. The ground space occupied by a set is 14 feet 3 inches × 9 feet. The dimensions of the generators are 9 feet outside and 6 feet 8 inches inside diameter, and 16 feet extreme height. The maximum capacity of one of these generators is said to be 400,000 cubic feet daily, but the average daily production has been found to be easily 300,000 cubic feet, with the kind of material now used, viz., "Sterling" coal. This coal is not a gas coal, but a superior blacksmith coal, which is largely used as a steam coal. About 5 per cent. of the fuel put into the generators is taken out when cleaning same. The cleaning is done once every 24 hours. The net results are 50,000 cubic feet of uncarbureted water gas made from each ton of coal used, and 150,000 cubic feet of inferior fuel gas per ton, which latter is consumed mostly under the carbureting retorts. The carbureting of the gas made in the generators is done in this way : Oil gas is made in the well known manner, in retorts formerly used for making coal gas, and the two gases, the uncarbureted water gas and the oil gas, are mixed at the inlet of the purifiers, and from there on pursue the usual course of all illuminating gas. Eight retorts are required to each generator used. Some of the retorts are still fired with coke. The coke fired retorts carbonize 7 gallons of oil per hour, and the gas fired ones, 9 gallons per hour. Four and $\frac{5}{10}$ gallons of 68 to 70° naphtha are used per 1,000 cubic feet of 25-candle power gas made. Including all labor, up to inlet of purifiers, 81,500 cubic feet are made per man employed. When anthracite coal or coke is used in the generators, the producing power of same is increased about 25 per cent. The writer has seen gas made in this manner, elsewhere. It was seen in operations where steel was melted, bars, plates and rods made, and all work done, from tempering watch springs to making large circular saws, files and other tools. At the same time gas was drawn from the holders, supplying factories, to heat dwelling houses, and with the aid of the Auer, or Welsbach incandescent gas burner, light them too, in a very superior manner.

There should be food for serious reflection in all this for such of the members of this Association as are located in manufacturing districts, as the uncarbureted article can be produced very cheaply, as you can figure for yourselves from the data given.

It would seem to the author to require no great stretch of imagination to suppose a suitably located gas works, furnishing during the daytime the many millions of cubic feet of good gas for fuel, which, when supplied cheap enough, would, beyond doubt, not only be used by those already so fortunate as to be near such a plant, but it would attract other factories to the neighborhood ; because cheap gas for fuel would cheapen manufactures of various kinds and add not a little to the comfort of mankind by effectually ridding suffering communities of the smoke nuisance, so often and so widely complained of. At night a small portion of the plant only would suffice to easily supply the necessary illuminating medium by means of the Auer or other incandescent burner, or by carbureting the gas in the ordinary manner.

There would be no need of the immense holder capacity which some have anticipated, none whatever ; and the whole matter seems feasible, is practicable, and seems financially desirable for persons who are looking for a safe, profitable investment of money.

This paper would be incomplete without reliable data for comparison. Hence the everyday results with a more generally known method of making illuminating water gas are given, and a set of the Improved Lowe Water Gas Apparatus has been selected as the standard. These results are not quoted as the best attainable by any means with the apparatus named, but are such as any one may easily obtain under like conditions.

(The unprofessional auditor or reader will please note that in all the results herewith given, the cost of purification, repairs to works, maintenance of plant, distribution, and the dozen or more additional items—all of which comprise in total the cost of gas at the consumer's burner—are not included, because these form no part of this subject at all.)

The apparatus giving the following results consists of a generator 6 ft. outside and 4 ft. inside diameter, and 13 ft. 9 in. in extreme height ; a carbureter of about the same outside dimensions, and a superheater or fixing chamber of like outside diameter and 20 ft. high, also a hydraulic seal and a scrubber and condenser. The whole apparatus is easily accommodated, including ample working room, in a space 18 ft. by 50 ft. During a certain month, when the conditions of atmosphere and earth were most agreeable for obtaining exact results, the apparatus was operated a portion of each day, and the total hours run were 363 ; number of runs made, 1,048 ; gas made per run, 4,417.74 cubic feet ; gas made per hour, 12,754.27 cubic feet ; made per man employed at apparatus per day, 77,163 cubic feet. To produce 1,000 cubic feet of 24-candle power gas required 4.67 gallons of 70° naphtha and 52.74 lbs., all told, of coal. This included all material bought, hence, waste or shrinkage as well. Had the apparatus not been idle more than one-half of the time, naturally better results would have been expected and made, for while standing idle the consumption of fuel in both boiler and generator continued—reduced, of course—but, nevertheless, it was wasteful.

In conclusion, permit me to say, that the comparatively recent history of water gas, and its triumph over all obstacles, once more reminds us that "Great is Truth, and it shall prevail," and again emphasizes the old, old lesson, that everything has two sides, which in turn should remind us, that though we have frequently brought to our notice, illusive, impracticable, sometimes only supposed—though in reality obsolete—alleged improvements for making gas, we should not aim to be too conservative and reject everything indiscriminately which may be honestly presented for our consideration. Remember, that while it may be commendable (within reasonable limits) to be conservative, to be progressive (with judgment) is no less so, to say the least, and the record in water gas is in evidence of that, as one of the most recent blessings of this progressive age.

[*Supplement to the Initial Paper.*]

Having received a number of inquiries upon subjects treated in the article published under above caption, it has occurred to the writer that additional information would be desirable at this time. It is to be hoped that the members of the Association will not be backward in supplementing or correcting matter, which the writer has had the honor to place before them. For instance, one of the processes mentioned, was in what the author would consider merely the experimental stage, when inspected by him. Although that would not excuse the unfounded claims made by its promoters at that time, it may have greatly improved since, and if so it surely must interest all progressive gas men to know the real facts as they now may appear.

The writer has tabulated the figures quoted in the body of the first paper under discussion, and added for comparison known results ob-

| Reference No. | Name of Apparatus. | Kind of Fuel Used in Apparatus. | Pounds of Fuel Used per 1,000, Exclusive of Steam. | Gallons of Oil (Naphtha) Used for 1,000 Cu. Ft. | Gallons of Crude Oil Used per 1,000 Cu. Ft. | Candle Power of the Gas. | Cu. Ft. of Gas Made per Man Employed at Apparatus each Day's Work. | Remarks. |
|---|---|---|---|---|---|---|---|---|
| 1 | Improved Lowe..... | Anthracite ..... | 40.2 | 4.67 | ..... | 24.0 | 75,000 | Work intermittent. |
| 2 | Granger-Collins..... | Anthracite ..... | 40.3 | 4.57 | ..... | 20.0 | 75,000 | Work intermittent. |
| 3 | Springer..... | Anthracite and coke. | 39.9 | 5.29 | ..... | 18.4 | 120,000 | Year's average. |
| 4 | Pratt & Ryan..... .... | Anthracite and coke. | 42.6 | 4.89 | ..... | 19.0 | 120,000 | " " |
| 5 | Egner..... ..... | Gas coke..... | 31.0 | 0.75 | 3.51 | 20.8 | 87,585 | " " |
| 6 | Flannery..... | Anthracite ..... | 42.9 | 5.00 | ..... | 26.0 | 180,000 | " " |
| 7 | Rose ..... | Gas coal..... | 91.5 | 4.18 | ..... | 24.0 | Not known. | Experimentally. |
| 8 | Loomis..... | Semi-bituminous. .... | 44.8 | ..... | ..... | 25.0 | 81,500 | Regular average. |
| 9 | Rew..... | Youghiogheny..... | 36.0 | ..... | 4.31 | 25.0 | 66,600 | Average to date. |
| 10 | Rew..... | Du Quoin nut ..... | 48.0 | ..... | 4.36 | 26.0 | 66,600 | " " |
| 11 | Jerzmanowski ..... | Crude oil..... | Crude. | 7.00 | 2.85 | 27.0 | 150,000 | Year's average. |

tained with other apparatus for the production of illuminating water gas. No. 1 was as described on page 66, No. 1, Vol. XI, of our published proceedings, operated only a portion of each day. Had it been run to its full capacity, the results must have been very materially improved. We have been informed that some apparatus of the type in question, produces 1,000 cubic feet of gas with less than 28 pounds of coal in the generator, and the author designed a large apparatus more than eleven years ago, which required less than 30 pounds per 1,000 cubic feet. The figures given in the table, should not therefore be regarded as intended to be a standard or citerion of the performance of the apparatus named, but simply a statement of results which came within the author's personal experience.

No. 2 was obtained from the averages of an apparatus erected twelve years ago, operated almost constantly for eleven years, and which is still in good order.

Nos. 3 and 4 are averages of a year's work, during which a good deal than more 300,000,000 cubic feet of gas were made by both styles of the apparatus named.

No, 5 is the average of one year's work, as mentioned on pages 59 and 60, current volume of the "Proceedings."

No. 6 is the average of a number of months' operations on a large scale.

Nos. 8, 9 and 10 have been extensively referred to in the text of the July number of the Association "Quarterly." Since the publication of the July number of the "Proceedings," some inquiries relative to the process described, were received by the writer, who, however, can add but little to the information previously published, hoping, as he trust others may, that further and desirable facts bearing upon these matters, may come before the Association at the coming meeting. A question about the nature of the fuel gas produced in connection with No. 10, can be answered by the author only to the extent that he was assured that from 17,000 to 19,000 cubic feet per hour, of same, was required in the carbonizing retorts, which ordinarily consumed about 56 bushels of gas coke in 24 hours to do nearly the same work. In an analogous process of gas makin , the author found that 8 pounds of coke were consumed per 1,000 cubic feet of gas carbureted in the retort benches.

Of course, had any one of the improved retort furnaces been used instead of the old fashioned one which *was* used, less fuel per 1,000 would have been the result.

In comparing results, it should always be remembered that the gas maker, the man who handles the valves, is an important factor with any process. With No. 1, for instance, it was found that one operator used upon an average, one gallon of oil less per 1,000 cubic feet of equal quality of gas than another did. It was only after weeks of careful instruction and effort on the part of the man himself, that he was finally able to do as well as the first man did. It is a mistake often made, to suppose that the great apparant simplicity of making water gas, makes it therefore possible to employ as gas maker, any sort of a man who can jerk a valve up or down, or just has sense enough to turn on and off steam and oil every set number of minutes, and whose principal qualification is that he can be had very, *very* cheap. *It is a costly mistake invariably, to the company*, as every one who has made gas making really a study knows. The quantity of coal required to produce the necessary steam has not been touched upon in this article, because the amount of steam required varies but little in any process, and because the manner of its production has nearly everything to do with it, if that item of water gas manufacture costs much or little. The fuel actually required, ranges all the way from less than six to over twenty pounds per 1,000 cubic feet of gas made. Here, as in generator work, much depends on the good sense of the firemen, and general intelligence of the manager of the apparatus. Twelve pounds per 1,000 would seem to be the average, but is by no means good work; besides, as you all must know, the style of boiler cuts an important figure as to the economy of fuel needed to raise of steam.

And now, in closing my paper, I desire to say that the author is not unconscious of the censure administered frequently to one who ventures, generally with the best of intentions, to write for publication professionally, or as we do in our Association papers, as contributors to our proceedings. It is not a difficult matter, *not to write*, and the writer is aware that he may often be found fault with, for doing what must be done by some one, if we are to continue to have profitable meetings.

*Discussion.*

In answer to a question, Mr. Egner said that in the case of the process mentioned as being in use near New York and using Sterling coal, the figures he believed to be correct as given him by the superintendent, for with a similar process he had secured even better results. Five per cent. of the coal coked in the generator was used under the furnaces, and the 12 lbs. of fuel used for steam purposes covered all the steam used for all purposes.

Mr. Addicks gave results obtained in the Flannery apparatus. The coal in the generator, making 930,000,000 feet per year, was 34.55 lbs.; naphtha, 4.73 gals.; candle power of gas, 25.68. The coal includes 6 per cent. added for shortage. The oil measurements were based on shippers' figures and not as received by the Company. To make it plain, he added the coal for the boilers, which was 12.61. There was no new coal used for steam outside of the slack which comes in the hard coal. The rest was screenings from the generator. The total fuel coal for the entire year amounts to 47.16 lbs. That was partly shavings that came from the purifiers, about 0.47 lb. The coke under the boiler—.08 lb. —was the coke used for screening out the tar; the coal screenings, .97 lb.; the cinders, 11.09 lbs.; shavings, 0.47 lbs.; total boiler fuel, 12.61 lbs.

Mr. Egner thought that Mr. Addicks' results with the Flannery apparatus were excellent. The results given by Mr. Egner were from averages of four months' work with from six to eight generators; the coal used for steam depends largely upon the boiler. A plain cylinder boiler surrounded with brick will make a very great difference even in the firing of the boiler itself.

Mr. Addicks remarked that some works are very large and are exposed to severe snow storms, and the surplus steam is required to take care of the holders a larger number of days in the winter than ordinarily.

Mr. Gibbons said that he was present with Mr. Egner at the time, and gave him the statements with reference to the working of the Rose apparatus. The gas was measured by a scale on one of the columns of the relief holder, and not by the meter. Soon after taking charge, he had the meter repaired and put in operation; and in his quarterly report to the Directors of the Company, on April 1st, 1893, he estimated that 67 per cent. of the gas manufactured up to the time of starting the meter was unaccounted for. From the time the meter was started March 12th to April 1st, he estimated that 9 per cent. of the gas made was unaccounted for. On July 1st he believed that the 67 per cent. was too high, while the latter, 9 per cent., was too low, as the loss by shrinkage in condensation from the station meter to the consumers meter was 14 per cent. The 12-inch outlet from the machine was connected to a 6-inch inlet, and to the 6-inch outlet of the relief holder without a valve intervening. Thus he found upon arriving at the works that he could not make gas and exhaust it from the relief holder at the same time. In order to remedy this defect he was connecting a 12-inch wrought iron pipe when Mr. Egner came to the works, A second defect that he found in the machine and partially remedied, was that the take-off from the hydraulic main was only a 2-inch pipe, and that had also to carry the waste water and drip from three scrubbers besides, and to carry it almost on a level for about 60 feet, from the outside of the building to the relief boiler. After getting the machine in successful operation he could not make gas for less than 22 cents; using soft coal, with screened nut coke and Pennsylvania crude oil. He obtained with anthracite coal the best and the worst results while he was at the works, viz: 21 cents and a fraction, and 28 cents and a fraction, per 1000 for material. All these defects which have been mentioned in the machinery have now been remedied by the inventors, and he believed a good candle gas with bituminous slack could be made with the process referred to.

Mr. Loomis stated that with regard to the work at Williamsburg, N.Y., since that time, and during the summer, the entire works had been running on water gas altogether. The last month's statement in regard to the amount of coal per 1,000 feet of commercial gas is 31 pounds in the generator and 9 pounds including everything else, making a gross of 40 pounds. The oil is decomposed in the retorts, and the gas is made in the generator; 4.81 of oil includes all the drip oil and everything that is used outside of the producer gas made in the generator in carbureting the gas.

Mr. Bowen then entered the discussion, giving several criticisms on Mr. Egner's paper, and quoted one user of the process designated in Mr. Egner's table as No. 7, as making a 22.6-candle power gas with 36 pounds Kanawha slack, 14 pounds coke, and 2¼ gallons of gas naphtha. The coke was used not for generator use, but for fixing purposes, and the proportion of slack to coke varied with the size of the machine, from 5 to 1, to 3 to 1. Soft coal should be used for water gas, as dollar for dollar more heat units could be had from it than from other fuels. Gas to be good must be high in heat units, whether for heating, incandescent burners or power purposes.

Mr. Shelton called special attention to the fact that the make of an apparatus, in varying from 75,000 to 120,000, is dependent more upon the size than the form of apparatus, whatever that might be.

Mr. Egner agreed with Mr. Shelton and noted a correction to be made in his table, to make it say that No. 6 made 80,000 instead of 180,000 cubic feet of gas per man.

The matter of the Secretary's editorial blue pencil was then warmly discussed in its relation to remarks of an advertising nature appearing in the proceedings, Mr. Clark intimating that it was one of the objects of the Association to get all the information on all points possible in connection with the industry, and that the men who knew the facts should be permitted to state them.

Mr. Addicks claimed that almost all of the discussion under consideration was due to the fact of the paper having been published so long before the meeting as to have given ample time for every one to digest it.

Mr. Shelton commended Mr. Egner's paper, but objected to part of the discussion.

Mr. Bowen objected to the elimination of any part of the discussion, as being unfair to those who felt called upon to respond to any statement in papers presented, noting the difficulty in drawing any set line as to when any statement of facts should be considered an advertisement.

A motion directing the Secretary to expunge part of the discussion was then put and lost.

The President then introduced Mr. C. H. Evans, who read his paper on

## PETROLEUM: ITS PRODUCTS AND THEIR RELATION TO THE GAS INDUSTRY.

Years ago petroleum was first discovered in the United States by the Indians, who observed a thin, oily film floating on the rivers of Pennsylvania. Their means of collecting it was by spreading their blankets on the surface of the water till they became saturated, then squeezing the oil so collected into vessels. This oil, which was believed to possess great medicinal properties, was used by the Indians for almost every ailment, and was bottled and sold quite freely to the white population, under the name of "Indian oil," as a remedy for sprains, bruises, rheumatism, and, in fact, almost every disease common to mankind.

Petroleum is found to exist in the United States, saturating porous strata of sand rock. The first well began to flow at Titusville, Pa., in 1859. The regularity of these oil sands, as regards their thickness and the intervening distance between them, is quite remarkable. In the Oil Creek district the first oil sand is found to be about 40 feet thick, with an interval of 165 feet between it and the second sand, which is 25 feet thick; a distance of 110 feet occurs between the second and third, the latter being about 38 feet thick. In a great many places the sand rock disappears, its place being taken by shales at the same geological horizon. Petroleum is generally considered to have resulted from the slow decomposition of vegetable or animal matter, either in the rocks in which it is found, or in underlying strata. Berthelot, however, in 1866, propounded the theory that petroleum was formed by the action of carbonic acid and steam on the alkali metals.

In 1867, Mendelejeff read an essay before a chemical society of St. Petersburg, and gave in detail his reason for believing petroleum to be produced by the action of water upon iron and carbon at a high temperature and under a great pressure. From recent researches I am led to believe that the varieties of petroleum found in Ohio, Pennsylvania and New York are distinctly of vegetable origin, while the California and Kentucky oils are without doubt of animal origin.

De Kramer gives .78 and .97 as the extreme limits of variations in specific gravity of liquid petroleum. In this form it consists almost entirely of carbon and hydrogen, C, 84 per cent., H, 14 per cent., and O, 2 per cent., being a fair average analysis. In 1863, Pelouze and Cahours succeeded in separating 12 distinct hydrocarbons from petroleum, which were found to be homologues of marsh gas ($CH_4$). The depth of petroleum wells has gradually increased in the United States, from 430 feet, in 1861, to 2,500 feet, or more, at the present time, the famous Gordon well in Washington county, Pa., being 2,400 feet deep. The producing wells in the United States number 30,000 or more, but the great majority furnish only a few barrels of oil per day, although some are stated to have yielded as high as 280,000 gallons per 24 hours for a short time. The ordinary life of a well that is worked is about four years. The growth of the oil business in this country is phenomenal. In 1860 something less than 100,000 barrels was produced, while in 1893 it reached the enormous figures of over 3,400,000,000 gallons. Something like 900,000,000 gallons of this was exported to other countries. It is quite evident that, with this wonderful production, increasing year by year and being gradually reduced in price by competition with foreign products, that the water gas companies have no uneasiness as to the future, and coal gas companies might even put aside that old bugbear "that the use of and demand for such large quantities of oil would raise the price of oil to such a point that it would be out of reach for the economical production of gas."

It is well known to you all that distillation is the means used to separate the different gravities of oil from crude petroleum, and that by the application of different degrees of heat the various products are produced. The first product is rhigolene and is exceedingly volatile and perfectly colorless—it has a density of 90° B.; then follows gasoline, 88° to 86° B. boulevard gas fluid for street naphtha lamps; benzoline, 74° B., for gasoline stoves; benzine, 62° B., and so on down to the lubricating oils and paraffine, finally resulting in a deposit of solid coke or carbon. In the application of the products to the gas industry, those which interest us most are between the gravities of 38° and 70° B., as shown below, in Table No. 1.

*Table No* 1.

| Density, Baume. | Specific Gravity. | Weight per Gal., 231 Cu. In. |
|---|---|---|
| 38° | .839 | 7 lbs. |
| 40° | .830 | 6.92 " |
| 42° | .820 | 6.84 " |
| 44° | .811 | 6.77 " |
| 46° | .802 | 6.69 " |
| 48° | .794 | 6.62 " |
| 50° | .785 | 6.54 " |

| | | |
|---|---|---|
| 52° | .777 | 6.47 " |
| 54° | .768 | 6.39 " |
| 56° | .760 | 6.32 " |
| 58° | .753 | 6.24 " |
| 60° | .745 | 6.17 " |
| 62° | .730 | 6.09 " |
| 64° | .721 | 6.02 " |
| 66° | .712 | 5.94 " |
| 68° | .708 | 5.87 " |
| 70° | .694 | 5.79 " |

The most important item in the cost of carbureted water gas is without doubt the oil. The quantity used per 1,000 cubic feet of gas made at the different works throughout the country is even more varied than the different processes in use, while the various gravities of oil used have their staunchest advocates in their respective grades. There does not seem to be that unit of opinion so desirable among gas engineers on a subject of so much importance to the gas industry. My inquiries among numerous gas companies, as to the quantity of oil used to carburet 1,000 cubic feet of gas, have developed a most deplorable condition of affairs at some works; while at others the claims made are, to my mind, too good to be true. The two extremes which have been brought to my notice are represented by the figures of 2⅞ gallons—44° B. gravity crude oil per 1,000 cubic feet of 22.50-candle power gas, made by one fortunate individual, and 9 gallons per 1,000 cubic feet of 24-candle power gas, made by a poor unfortunate whose troubles are too serious to deserve censure. The problem before us is what gravity of oil shall we use and how shall it be treated to obtain the best results. The manufacturers and promoters of the too-numerous-to-mention gas apparatus on the market to-day leave the would-be purchaser in a quandary as to which is the one to be desired, each claiming superior merit in construction, and each claiming to use a less quantity of oil for a given quality and quantity of gas than all others. I do not propose to discuss the merits of any particular gas apparatus in this paper, but wish to confine myself mainly to results.

It will be noticed, by reference to the above table of specific gravity and weights of various degrees of petroleum, that 38° B. is 17.4 per cent. heavier than 70°, and it would be fair to presume that the former would, if properly handled, give results in gas making equal to the difference in weight. Such, however, is not the case in practice, owing chiefly to our methods of using it, and, in a degree, to the difficulty of preventing the formation of tar. This latter element is the bane of those who use crude oil, but it can be largely overcome by carrying extremely high heats in your superheater and avoiding, as much as possible, all back pressures when a run is on. By experiments I have satisfied myself that crude oil, to be used successfully, should be atomized to the highest practical degree when injected into the superheater. This should not be done with steam, as is practiced by some, unless perfectly dry and at a very high pressure, as the excess of water vapor carried over through the generator, together with the usually wet steam used to inject the oil into the superheater, have a tendency to form carbonic acid ($CO_2$), in quantities sufficient to very materially increase the quantity of oil necessary for the desired candle power. It has been suggested by a prominent gas engineer that hydrogen gas (so called) under pressure could be used for this purpose with great beneficial effects.

A short time ago I made several experiments to ascertain the exact quantity, specific gravity and candle power of gas that could be obtained from a gallon (231 cu. in.) of oil of different gravities. The apparatus I used was so constructed as to collect all condensation readily, and in fact, to recover any products that might remain after the gasifying was completed. All condensation that appeared was drawn off and passed through the apparatus; this was repeated until no further condensation appeared. How much of the total weight was converted into gas will appear in the figures below, marked Table No. 2.

candle power gas from 2.7 gallons crude oil. I am, with several others, anxious to be enlightened in order that we may do likewise. The commercial gas represented by the former was reported to be composed of 72.95 per cent. of hydrogen and 27.1 per cent. of naphtha gas. If this be true, then the cubic feet obtained per gallon would be 66.75, and the candle power 110.50. I am aware that the observed candle power does not do justice to the enriching value of the heavy oil gas. This is due no doubt to the imperfect means at our command for burning perfectly a gas so heavy with hydrocarbons.

It will be noticed, by reference to Table No. 2, that the enriching value of the oil gas is increased on an average of 56 per cent. by mixing with hydrogen gas. In other words, the hydrogen gas, when mixed with the oil gas, increases the flame temperature of the latter to such an extent that the minute particles of carbon are heated to a brighter incandescence, thereby giving a much higher candle power per given quantity of gas burned. The hydrogen gas used in the mixture referred to, though free from sulphureted hydrogen ($H_2S$), had about 2½ per cent. of carbonic acid ($CO_2$) and 1 per cent. of nitrogen (N) in its composition, the presence of $CO_2$ being due to the use of oxide for purification. If the N and $CO_2$ had been entirely eliminated, the candle power would have increased at least 3 per cent. Pure hydrogen gas (so called), free from $CO_2$ and N, high heats, preheating and atomizing the oil, and relief from back pressure, are all essential to obtain the best results. On the matter of heats I wish to dwell briefly. The same heat that will convert the oil immediately into gas will also burn the gas into lampblack, if left in contact with the highly heated brickwork too long. High heats not only increase the cubic feet of gas obtained per gallon of oil, but also increase the candle power. High heats form a different series of hydrocarbons, creating a larger percentage of the benzine series, which are known to add more to the illuminating power of the gas than the other hydrocarbons. This subject is one of deep interest to the gas industry, and especially so to the manufacturers of carbureted water gas.

In presenting this paper to the Association, I am well aware that, in all probability, it will convey but little information, if any, to some of its members, who have already, perhaps, given the subject even more careful consideration than myself; but if through its medium a single member shall have been benefited, then the object of the writer will have been attained.

*Discussion.*

Mr. Thompson considered the table which Mr. Evans had given of the comparative production in weight, candle power and volume of mineral oil as one of great value, and one which will long be used for reference. He asked him if one is carbureting coal gas by the retort process, manufacturing gas from oil by the retort process, what he would consider a fair value to put upon the quantity of gas made from oil so as to obtain his noted yield per pound of coal?

Mr. Evans replied that the loss by weight of oil noticed in the table was but little in pounds; but when oil is passed through the retort in the form mentioned the same results should be obtained, provided the exhauster was run under a slight vacuum to take the oil away, and not leave it in contact with the service too long, and get the heat as high as practicable and not form lamp black. The equivalent in pure gas from a gallon of crude oil was 70; candle power 83.5, being slighly better than 70° naphtha—that is in candle power, not in quantity. Naphtha gas is higher in quantity, being 83.3, and the candle power was lower, being 72. This was by experimental distillation.

Mr. Clark said he had been unable on a commercial scale to obtain more than 70 to 75 feet from day to day, of about 60-candle power gas, distilling in the retorts, and asked Mr. Evans at what heat distillation took place to obtain from naphtha 70 feet of over 80-candle gas?

Mr. Evans stated that he obtained 83 cubic feet of gas that had the equivalent of 72-candle power when mixed with uncarbureted water gas. When tested on the photometer bar no such results were shown as he stated there, evidently an imperfect method of testing light of such high quality.

*Table No. 2.*

| | Degs. B. | Specific Gravity. | Wt. Per Gal. 231 Cu. Ins. Lbs. | Cu. Ft. Gas Made per Gal. Oil. | Spec. Grav. Gas Made 62° F. (Air 1,000.) | Wt. Gas Made. Lbs. | Loss by Weight. Lbs. | Loss by Weight. Per Cent. | Observed Corrected Candle Power. Burning 2 Ft. per Hou , Using 2 Ft. E. H. Tip. | Candle Power Value from its Effect as an Enricher. |
|---|---|---|---|---|---|---|---|---|---|---|
| Lima (O.) crude oil | 38 | .839 | 7.00 | 70.0 | 1,315 | 6.53 | .46 | 6.66 | 56 | 83.5 |
| Northern (O.) " | 44 | .811 | 6.77 | 73.1 | 1,272 | 6.52 | .24 | 5.06 | 54 | 82.0 |
| Ohio gas naphtha | 54 | .768 | 6.39 | 77.0 | 1,121 | 6.13 | .24 | 3.75 | 51 | 79.5 |
| " " " | 60 | .745 | 6.17 | 81.2 | 1,040 | 6.03 | .13 | 2.16 | 47 | 78.0 |
| " " " | 70 | .694 | 5.79 | 83.3 | 900 | 5.67 | .11 | 2.00 | 45 | 72.0 |

With such figures before me it is difficult to reconcile some statements which have reached me regarding results obtained by the addition of 4.06 gallons of benzine, 70° B. per 1,000 cubic feet of gas made, or a 22½

Mr. Pearson, Jr., asked if the commercial value of naphtha and crude petroleum had been considered? In using gas oil, in Toronto, where they could utilize petroleum tar under the boilers altogether, they used fuel other than petroleum tar at present, and that enabled them, by using the distillate, to do away with all other boiler fuel. At present they were making gas with a little less than 30 pounds of coal or coke, that being the total of boiler fuel, and the coal used under the generator. About 2½ barrels of tar may be said to be equal to about a ton of coal for fuel. Tar made equals about 10 per cent. of the oil used.

Mr. Egner stated from his experience with the Pintsch gas that Pennsylvania crude oil gave: Feet of gas to the gallon, 70.49; candle power, 45.5; Pennsylvania naphtha, 50.90 (poor sample); candle power, 46; Lima crude oil gave, feet per gallon, 63.16; candle power, 56.2; Lima naphtha, 61° gravity, gave 72.15 cubic feet per gallon; 45.8-candle power.

The candle power given is that of uncompressed gas, with flat flame burner; but the burner was a small one for oil gas of 2.4 cubic feet per hour. The tests were made by Mr. B. E. Chollar.

Mr. Gartley remarked that in cases where a candle power of 24 is obtained with 2¾ gallons of oil, an analysis of the gas would show that the illuminants in the gas weighed more than the oil before it entered the machine. There are some illuminants obtained by the distillation of soft coal going on in the machine.

On motion of Mr. Gartley the thanks of the Association were voted to Mr. Evans for his paper.

As Mr. J. P. Harbison was unable to serve on the Committee on President's Address, of which he had been appointed Chairman, the President appointed Capt. Wm. Henry White to serve in his stead.

The Association took a recess until 2 P.M.

[To be continued.]

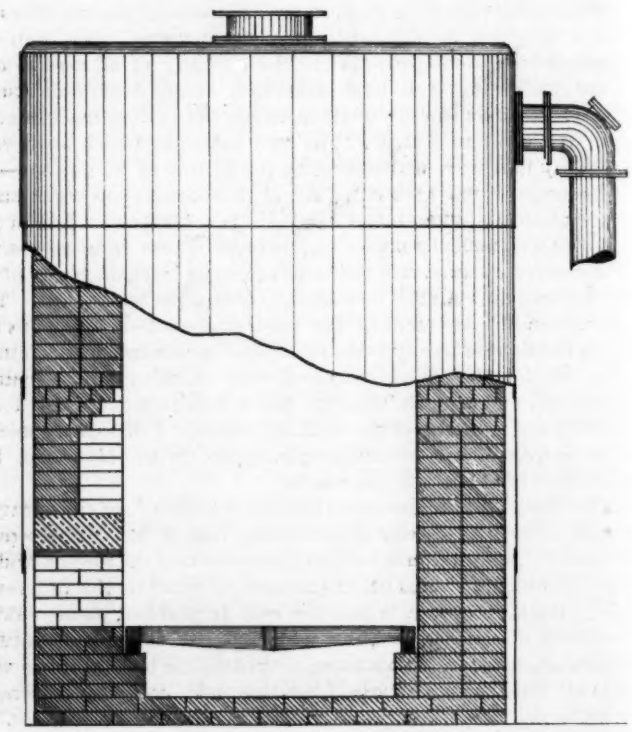
## The Pitting of Boilers.

In an article recently published, M. Olroy, a French engineer, gives the result of his investigations into the pitting of boilers. Pitting is particularly liable to occur if a water very free from lime is used in a clean boiler. The pits take the form of conical, or more frequently spherical depressions, which are filled with a yellowish-brown deposit consisting mainly of iron oxide. The volume of the powder is greater than that of the metal oxidized, so that a blister is formed above the pit, which has a skin as thin as an egg-shell. This skin contains usually both iron oxide and lime salts, and differs greatly in toughness. In many cases it is so friable that it breaks with the least shock, falling to powder, whilst in other cases the blister detaches itself from the plate as a whole. An analysis of the powder in the pits showed it to consist of 86.26 per cent. of peroxide of iron, 6.29 per cent. of grease and other organic matter, and 4.25 per cent. of lime salts, the remainder being water, silica, aluminum, etc. The skin over the pits was found to contain 38 parts of calcium carbonate, 12.8 parts of calcium sulphate, and 32.2 parts of iron oxide, with about 8 per cent. each of magnesium carbonate and insoluble matter. Feed heaters often suffer badly from pitting, particularly near the cold water inlet, and in boilers the parts most likely to be attacked are those where the circulation is bad, especially if such portions are also near the feed inlet. In locomotives the bottom of the barrel is most frequently attacked, and the largest ring. The steam spaces are generally free from pitting, unless the boiler is frequently kept standing with water in it. As the water evaporates, pitting is then likely to occur along the region of the water line, a part which in a working boiler is generally free from attack. This is especially the case if longitudinal joints of the boiler are liable to be exposed by the evaporation of the water, and to form a ledge on which moisture can rest. When a boiler forms one of a battery, and is kept standing for a long interval, the top of the boiler is liable to pitting. Steam finds its way into it, and condenses on the roof, causing bad pitting there. Perfectly pure water containing no air does no harm, and steam alone will not cause pitting, unless it gets a supply of air. The Loch Katrine water of Glasgow, which causes pitting on clean boilers contains much gas. MM. Scheurer-Kestner and Meunier-Dolfus inclosed a polished iron bar in a natural water containing much oxygen, and no lime salts. The bar gradually rusted, but the corrosion ceased when the oxygen was used up. The bar was then removed, repolished, and put back, after which it remained perfectly bright. Repeating the experiment with water containing lime, the rusting was much less complete, the lime salts forming a protective layer on the iron, but on polishing this off corrosion recommenced. In distilled water the bar remained quite bright. The corrosion is much more rapid if the water contains carbonic acid gas as well as oxygen. In this case a voltaic action takes place. The rust first formed is electro-positive to the iron, which then dissolves away, decomposing the water. It is for this reason that in cases of pitting it is essential that all traces of the iron peroxide should be cleaned from the metal, or the rusting will continue.

## An Economical Method of Lining and Relining Generators.

The following method practiced by Mr. J. A. McCollum, Superintendent of the Riverside (Cal.) Gas Company, has been found perfectly satisfactory for the purpose for which it was devised:

Reference being made to the accompanying cut, an effective and substantial, but comparatively inexpensive method of lining and relining water gas generators is illustrated. The lining shown is 16 inches in thickness, composed of 8-inch firebrick, cut to the proper radius, and



laid in consecutive header courses, from the level of grate base to a height of six courses above the lintel course, or to such height as may be required by the existing conditions. A succession of stretcher courses is now introduced, bonded as shown, forming a lintel for the remaining brick superstructure. The advantage to be derived from this arrangement is that the necessity of completely lining the generator is obviated, the inner course solely being subject to the action of the destructive heat. By replacing the destroyed inner course to the extreme point, the outer lining next the shell, and also the entire lining above the stretchers, remains substantially intact and unaffected.

## Inaugural Address Delivered by the President (Col. Sadler) of the North of England Gas Managers' Association, at Its 35th Half-Yearly Meeting.

Gentlemen—My first and paramount duty is to express to you my hearty thanks for the unsought honor you have done me in making me your President. I appreciate the compliment very highly. I feel that it is no common distinction you have conferred upon me when I remember that, although I have been connected with your successful Association ever since its formation, 18 years ago, I do not forget that my place has been in the outer temple only, as an associate. Advanced biological philosophers have propounded the astounding hypothesis that, by a transfusion of blood from one person to another, the teeming millions of newmicrobe life thus imparted may so entirely alter the character of the individual that his thoughts, opinions, tastes, and even pursuits, are completely changed. Although I do not remember the operation having been performed, something of the kind must have happened to me 30 years ago, for the course of my life and pursuits were then completely changed from a very dissimilar direction in an otherwise inexplicable manner; and since that time until to-day, my life and daily vocations have been associated with coal gas and its bye-products. Al-

though not a gas engineer, manager, or gas expert, my claims to being a gas maker are of no mean pretensions. Let me hasten to explain. I do not refer to oratorical "gas" of poor illuminating power which, in my numerous public capacities, I have for many years retailed in too bountiful quantities to long-suffering audiences; nor, indeed, to that gas of more pungent and permeating nature which I have gratuitously distributed to unappreciative and unadmiring neighbors from our several chemical works. But for many years—nearly 20—I have carbonized from 20,000 to 25,000 tons of coal per annum in ordinary gas retorts, the gas being employed for purely chemical purposes. I mention this because some of my friends, unaware of the circumstances, wonder by what right or title I could justify my acceptance of the honorable position in which you have placed me.

Your trade is well off for literature, and it is intelligently and admirably served by its journals. Gas making is now a recognized profession, and it is conducted on purely scientific lines. Your profession abounds with able and thoughtful men, who generously and ungrudgingly give their brethren the benefit of their learning and experience. There is no question affecting the industry, whether chemical or technical, that is not almost weekly discussed. It is therefore difficult to say anything interesting, and more so to say anything new, in connection with gas. I had intended to contrast the present position, from a chemist's point of view, with that of 30 years ago. But this has been strikingly set forth in recent numbers of the *Journal of Gas Lighting*, and there is little to add.

The value of chemical knowledge in conducting a gas works has not been recognized until very recent years. No industry of this magnitude has ever continued so long in a groove of self-satisfied ignorance of the scientific principles underlying the process. Prejudice against any proposed improvement in manufacture, and the mysterious secrecy affected by some, seriously prevented that progress which can only come from scientific knowledge. Nothing brings out the qualities and capabilities of men better than competition and rivalry. The latter was probably the first incentive to inquire below the surface for information and light. When it was found, by published reports, that one gas maker obtained better returns than another, the spirit of emulation awoke, and improvements at once became manifest. But the advent of the electric light, and the serious competition from it, was the talisman that aroused the latent abilities of gas engineers. The amazing rapidity of inventions, improvements and economies in gas manufacture during the past 15 years speaks volumes for the ability and enterprise of those connected therewith. Perhaps one of the best illustrations of the rapid advance made will be found in the great improvement in the light to be obtained from gas. This is, to my mind, quite as much seen in the modest, but ingenious, little batswing or fishtail burner, as it is in the more assertive and imposing lamps for open places, which all the same redound to the credit of the successful inventors and manufacturers who specially produce them. In my opinion, the youngest child in this family—the "mantle" or incandescent burner—bids fair to be the most robust of all, for chemically, economically and sanitarily there is much to recommend it. I was forcibly struck with the beauty and effectiveness of the light a week or two since in Paris, where that magnificent square, the Place de la Concorde, is wholly lit by it. It looks superb.

Until a comparatively recent period the constitution of coal gas was not generally known. As soon, however, as it was seen how small was the percentage of the whole of that part which contributes to the illuminating power, various expedients were devised to increase it; and what is now commonly known as "carbureting," in one form and another, found at once a place in the manufacture. The use of cannel is the oldest form of carbureting. Rich in bituminous matters, on destructive distillation the hydrocarbons pass with the gas both as permanent gas at ordinary temperatures and as vaporized liquids at great tension. Paraffine and petroleum ethers are simply refined forms of cannel enrichers, since their capacity for the work is due to the same class of hydrocarbons as those derived from cannel or other schistous coal. The most natural, and, at present prices, the most economical carbureter is undoubtedly benzol. I say the "most natural," because from 70 to 75 per cent. of the illuminating power of ordinary gas produced at high temperatures is mainly due to benzol. Then the source of all benzol in the market is tar or gas itself. As gas rarely contains more than 2 per cent. of benzol, it will be seen what a potent illuminating agent it is. It is reported that the Gas Light and Coke Company have decided to use for carbureting any benzol they produce, unless it can be sold at 31 cents per gallon. But I claim it to be the cheapest enricher even at 62 cents per gallon. To the richness of benzol in carbon is doubtless to be attributed its value in this direction. In that light one cannot but contemplate what a fine field of usefulness is open to that substance which is now a scourge to both gas makers and tar distillers. Needless to say, I allude to naphthaline. Extremely rich in carbon, *if* it could be distributed—and that is only a question of temperature of the mains—and *if* it could be completely "combusted," which is merely a question of the supply of oxygen, it would be the perfection of enrichers There is "much virtue in an *if*," surely.

Reverting to benzol as a carbureter. Ordinary gas at normal temperatures will easily carry 3 per cent.—this being nearly the point of saturation. Now, as average gas contains less than 2—often only 1.5—per cent., 1 per cent. may be added with great advantage where increased illuminating power is desired. An addition of 1 per cent. will raise 14-candle gas to 22-candle power, which at to-day's price of crude benzol, would cost about 1 cent per candle. For enriching gas benzol is 3 times better than carburine, and 4½ times better than ordinary petroleum spirit. If all the gas made in the United Kingdom were enriched by 1 per cent., it would require 11,500,000 gallons of benzol to do it, a quantity more than twice as great as the whole world's yearly production. When gas contains an admixture of other gases besides hydrocarbons—hydrogen, carbonic oxide and nitrogen, for instance—the absorbing power for benzol is enlarged. It is, therefore, a matter of calculation and management whether it will pay to extract more gas from the coal in the retorts, even supposing it be carbonic oxide, and make up the luminosity with benzol. So-called water gas takes up benzol with avidity. It is worth bearing in mind that carbureted gas, whether with benzol, petroleum spirit or light hydrocarbons from cannel or from oil gas, will dissolve readily any deposited naphthaline in gas mains and also in gas fittings.

The importance of the application of benzol to enriching gas appeals to us in this, that it will utilize the surplus beyond that required for the manufacture of aniline. The magnitude and rapidity of the increase in the production of benzol and its homologues during the past ten years is remarkable. It is difficult to obtain reliable figures; but I think I am near the mark when I say that this year's output will be upwards of 4,000,000 gallons, while ten years ago it was under 1,500,000 gallons. It is marvellous how so large and rapidly increased an amount has been absorbed by the market; and, having regard to the depression of the textile trades for several years, it is difficult to believe that the large quantities of anilines represented by the great production of benzol could have been required. Unquestionably, lower values have opened up outlets which were impossible before.

It takes one's breath away to remember that benzols were realizing ten years ago $3.75 per gallon, while to-day's net value "naked" is less than 25 cents. It is right to add that previously, in the early seventies, the price was no better than it is to-day. It was about that time, as well as in the infant days of our Association, that I strongly advocated the application of benzol for raising the illuminating power of gas; and for many years Mr. Verini, of the large Zetland Hotel, Saltburn, recognizing its value in this way, passed all the gas consumed in the hotel through an ingenious spiral arrangement in a closed circular box, the inner partitions of which, being made of flannel, sucked up the benzol by capillary attraction, and in this attenuated state it was rapidly imparted to the passing gas. The simplest and cheapest carbureter (for its efficacy I can vouch from long experience) is to pass the gas over the surface of benzol which is slightly heated with a steam coil in a small closed tank of any kind.

The prodigious, and I fear ever increasing production of benzol, and the certainty of lower prices, must be my excuse for appealing to gas managers to use it in preference to, or mixed with, other carbureting agents. In doing so, the value of tar will be improved, and overproduction will disappear. Moreover, it is the cheapest and most natural fortifier. I admit that this is special pleading, and I regret that the occasion necessitates it. I confess all the same to feeling like a base ingrate, in humiliating to such commonplace and menial work a product of vast chemical importance, which has been one of my best friends, as well as of many other chemical manufacturers.

The benzene molecule, as the chemical combination of 6 atoms of carbon combined with 6 atoms of hydrogen is called, is one of fascinating interest to the chemist. Like many another, I fell over head and ears in love with her in my too susceptible youth. How ardently I wooed her, in my young enthusiasm, for her brilliant qualities! How often I thought she slighted me for more pressing admirers! How I waited for her, and she did not turn up—the trysting spot being the odorous and sequestered shades of the laboratory! How I sought for her in impossible places! How I worshipped her when she sometimes capriciously turned up unexpectedly! How I importuned and pursued her and pressed my suit when she was not disposed to stay with me! How I was stricken with her marvellous attributes! How I was dazzled as she

suddenly appeared to me in rainbow hues! How I sighed for her to return when, a little heated, she suddenly assumed invisible form! How, in short, she was my ideal and adored Molly Cule, worth $2.50 per gallon. How I found out, on more intimate acquaintance, that the benzene molecule—this foremost member of the aristocratic aromatic family—was, I regret to say, a loose character! Although legitimately united to several atoms of hydrogen, she was not averse to exchanging them for other atoms, or even for combinations of atoms of a hybrid formation and character. It is not surprising, after such shocking lapses, that she stooped to subterfuge and deception. She dropped her name with the oriental prefix and shamelessly assumed rakish titles and fancy designations, such as Toluol, Xylol, Phenol, Mirbane, Aniline, Rose-Aniline, Induline, Saffranine, Leucoline, Recorcine and scores of others. It is said that "a rose by any other name would smell as sweet." But she, with the first change, as Nitro-Benzol, became intensely fragrant; then, with subsequent divorces and unions, she affected the most brilliant garb—now vieing with the rising crimson sun, then with the azure sky. Indeed, neither the rainbow nor any flower of the garden, however intense in color, can compare with the marvellous hues and variety she adopted. This moral turpitude, or loose affinity of the atoms constituting the benzene molecule, returning to practical language, is of incalculable usefulness in the arts for synthetic purposes, benzol being the most prolific source of synthetic products at the command of the chemist.

The most glorious chapter in chemistry—indeed, it reads like a romance—is that commencing with Faraday's discovery and isolation of benzol, and subsequently its chemical relation to benzoic acid, a natural product; the revelation of its properties by that martyr to the science of tar chemistry, Mansfield (who was burnt to death in the laboratory while investigating the products of tar, and whose name is held in grateful memory), and the classic researches of Laurent, Runge, Hofmann, Perkin, Caro, Graebe, Liebermann and Bayer, resulting in the discovery of a great number of interesting, useful and elegant products, all owing their existence to the benzol molecule.

The other tar products have not increased in anything like the same ratio as benzol, the great production of the latter being largely due to its extraction from coke oven gases. One-third of the total make comes from this source. The quantities, however, are astonishing, especially as they are now considered as a necessity of modern civilization and trade, and having regard to the fact that 30 years ago few of them were commercial commodities, while many were unknown beyond the precincts of the laboratory. Carbolic acid, or oxy-benzol, and its stepbrother, cresylic acid, were just becoming recognized as valuable disinfectants; my old friends, Dr. Smith and Mr. Crookes, having employed them, with miraculous results, in suppressing the great cattle plague—the rinderpest. Now, in the language of advertisement, "no well-conducted household should be without it. It is the best of all disinfectants!"

The most powerful explosive now known, melinite, an admirable smokeless powder, and several of the most charming dyes, owe their origin to its parentage and mobility.

Creosote, including naphthaline and the heavy tar oils, the annual make of which is little short of 100,000,000 gallons, are now important articles of commerce, being of great recognized utility for protecting wood, preparing lubricants, and lighting open spaces in the special lamps now extensively employed. Useful as they are, they are nevertheless made largely in excess of the world's present requirements—the surplus being utilized as fuel. More than 20 years ago I passed these oils through highly heated tubes, to convert them into more valuable bodies. The phenoloid hydrocarbons readily decomposed into benzols and anthracene, and the other hydrocarbons furnished a large yield of gas of high luminosity, which we mixed with ordinary gas for use on the works.

My firm has used many millions of gallons of tar oils as fuel; and I am sure it will interest you to hear what is the economic caloric value of them when burnt under suitable conditions. A good many years ago, I invented a simple and costless burner for tar oils, which neither the scores whom I have supplied nor I have much reason to desire to improve; and I will give you the result of our experience with it. Of course, the density of the oil affects the results; but, taking average creosote, I find that 1 pound will evaporate, in a well constructed and properly set steam boiler, 13 pounds of water at 100 pounds pressure. The Government dockyard for a time used all the creosote produced at our Portsmouth works; confirming this result. The experiment was made with a view of testing the adaptability of creosote as fuel for ships of war; but the difficulty of getting supplies, excepting at a few ports, prevented its adoption. Its compactness compared with coal—one part being equal to two parts of coal—and no stoking or labor being required, were, and are strong factors in its favor.

Anthracene is the most beautiful of all the tar products—in its pure state showing a dazzling opal fluorescence—as well as the most valuable of them. Unfortunately, it only enjoys a limited market, and has, so far but one use—the manufacture of alizarine or turkey red. My firm has spent $650,000 in an endeavor to utilize the anthracene made in this district, instead of its being sent to Germany, converted into alizarine, and returned here for use by our dyers.

Something like 50 per cent. of ordinary tar is pitch, the great bulk of which is used for briquettes or fuel making by mixture with small coal. The development of this particular trade is truly wonderful. Twenty years ago it was a comparatively small industry; whereas today the annual output of briquette fuel made with pitch is upwards of 4 million tons. The steady flow of pitch in the present market channel presents a vivid contrast with the strange devices and expedients adopted 25 or 30 years ago to dispose by "hook or by crook," of this unsalable article. I remember moulding it into bricks, and baking it into coke in specially constructed ovens—a laborious and unprofitable pursuit, which "eventuated" in my running the hot pitch *en masse* into large ovens, firing and thus coking it. A refractory pure coke is thus obtained. Pitch is now admitted to be the best and most economical agglomerating agent available for fuel; and at the present time it enjoys the distinction of being the only tar product which is not produced in excess of its requirements, though, with the continuous fall in the value of coal, I see no prospect of this advantage being long retained.

I must not close my address without saying something about sulphate of ammonia. Financially, it gives the best yield per ton of coal carbonized; and, though lacking the charm and attractiveness of some of the tar products, it is nevertheless equally interesting, in the utilitarian sense, because of its intrinsic value. The world's available production this year will probably be 235,000 tons; while ten years ago it was less than 100,000 tons, and twenty years ago about 35,000 tons. Sulphate of ammonia owes its value not only to the nitrogen it contains, but to its remarkable adaptability to agricultural purposes. The great increase in the manufacture of sulphate is a source of anxiety to many makers who have not taken the trouble to contrast its production with the world's actual and growing necessities for nitrogenous manures. Education, technical training, and the wide diffusion of scientific knowledge, will soon call for far larger quantities than can be made, especially when it is thoroughly understood how much more valuable is the nitrogen in sulphate than that contained in nitrate of soda. Then remember that the annual production of nitrate is 1,250,000 tons, while that of sulphate is less than 250,000 tons. There is room not only for all the sulphate now being made, but for any, no matter how much, that ever will be made. The world will be richer for every added ton of sulphate placed at the disposal of farmers..

A word or two about the coke ovens you have seen to-day at my colliery, and I have done. They may have a far-reaching influence on your industry. In the first place, some day—perhaps soon—they may prove to be the best means of making gas, as they certainly would be the cheapest and most wholesale way of doing it. After all, they are just a gas retort on a larger scale, carbonizing five tons of coal each charge. Secondly, the ovens yield 2,000 tons of tar, 650 tons of sulphate of ammonia, and 100,000 gallons of crude benzol per annum. At a moderate computation, 30 million tons of coal are coked in the United Kingdom in ordinary ovens. If this coking were done in closed ovens, and the residuals saved, the produce would be: Tar, 1,000,000 tons; benzol, 50,000,000 gallons; sulphate of ammonia, 300,000 tons. As showing how slow we are, there are 300 ovens of this class in England, while there are 2,650 on the Continent, and many more in course of construction there. Fortunately, the yields from the latter are much lower; the coal being less bituminous. Still the quantities of bye-products from them are a factor to be reckoned with. When it is remembered that these ovens give at least 15 per cent. more coke from the coal than is obtained from the old type of ovens, and further, that the worth of the residual products may be almost as much as the small coal used, the prejudice which prevents their universal adoption is stupid and beyond comprehension; but, taking the enormous loss to the country, it is worse—it is wantonly wicked and suicidal. My friend Mr. Simon, of Manchester, one of the most eminent and most successful engineers of our time, has for years endeavored to impress on English coke makers and metallurgists the immense importance of this question. The perfect arrangements you have seen to-day are largely due to his inventive skill and enterprise. After years of discouragement from sources where enlightenment and science had a home, and whence something very

different was expected, the great merits, advantages and economies of the ovens and plant, which will stand as an enduring monument of the ability and genius of Mr. Simon and M. Carvès for all time, are at last being recognized, and will rapidly occupy that place in the industries of this district far too long delayed.

## Experiments with Superheated Steam.

In March and April, 1893, a series of experiments on the relative consumption of steam and fuel with saturated and superheated steam was carried out by the Alsace Union of Boiler Owners. The experiments extended over a period of six weeks. The boiler installation consisted of five cylindrical boilers, each with three heating tubes; each boiler had 640 square feet of heating surface, and 27.8 square feet of grate. The firing was from below, and the boilers were designed for a pressure of 12 atmospheres. On the last boiler was fitted a Green's economizer heated by the waste gases from the five boilers and from a Uhler's superheater. The steam engine was horizontal, triple expansion, with Frikart valve gear, the high pressure and intermediate cylinders on one side, the low pressure cylinder and condenser on the other side, behind each other. The diameters of the cylinders were 18.8 inches, 28 inches and 48 inches respectively; the stroke was 56 inches, and the number of revolutions per miuute, 70. The principal results are exhibited in two tables, and the deductions made are:

1. Theoretically, it has never been denied that superheated steam should give a higher efficiency than saturated, yet from fear lest the cylinder should be damaged by the high temperature, for years no experiments were made with superheated steam. Now, however, after numerous experiments, the oldest engine can safely be used with superheated steam without injury, the economy being greater than with saturated.

2. In installing a superheater, care must be taken that the advantages gained are not lost either by less perfect combustion or by greater radiation losses. The cost of the superheater must, of course, not exceed the saving obtained in coal consumption. The superheater should be connected with the boiler so that both can be fired from the same furnace. After leaving the superheater the gases should come in contact with the heating surface of the boiler, and, lastly, with the heating surface of the economizer.

3. The use of superheated steam does not exclude the use of the steam jacket. Though both superheating and steam jackets were used, yet condensation in the high pressure cylinder occurred.

4. The two different kinds of coal used gave different results.

5. The use of low pressure, 7½ atmospheres, did not give such good results as the use of high pressure, 11½ atmospheres.

## ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

THE shareholders of the Montreal Gas Company have formally indorsed the action taken by their Directors in the purchase of the Consumers Gas Company. So ends the opposition scheme.

THE above mention recalls the fact that some evenings ago the Montreal Mock Parliament held its first session for the current season, and the initial debate was based on the following resolution: "Be it resolved that the city of Montreal shall hereafter control and operate its own gas works and carry on the same in the name and for the benefit of its citizens." Of course, the speakers who espoused the affirmative side greatly outnumbered those who spoke to the negative of the issue, nevertheless, when it came to vote, the ballot resulted in a majority against the favorers of municipal rule. Ex-Alderman Clendenning and Mr. George W. Stephenson, Jr., made telling arguments in opposition to the motion.

MISS ALMIRA M. WHITHED and Mr. Fred. Wellington Norton, of Nashua, N. H., were united in marriage on Wednesday, October 24th. The bride is the daughter of Mr. and Mrs. Solon Whithed, of Nashua, N. H., and the groom, who is a son of the late ex-Mayor Norton, is the clever and capable Superintendent of the Nashua Light, Heat and Power Company.

THE new holder of 200,000 cubic feet capacity, recently completed by Messrs. R. D. Wood & Co. for the Binghamton (N. Y.) Gas Company, has been accepted, the initial test having been eminently satisfactory.

MR. A. M. SUTHERLAND, proprietor of the "Little Giant" water gas generating system, writing to us under date of October 27th, says: "Talk about business being bad. It isn't, for I have just finished my third water gas plant since June last, which makes 5 in 14 months. This is the list: Clifton Springs, N. Y., started Nov. 1, 1893; Gainesville, Fla., Jan. 1, 1894; Lexington, Mo., July 1, 1894; Fishkill-on-Hudson, N. Y., Sept. 1, 1894; Joplin, Mo., Oct. 15, 1894."

THE Trustees of the Troy (N.Y.) Gas Light Company have named the following executive management: President, Edward Murphy, Jr.; Vice-President, William Kemp; Secretary and Treasurer, C. E. Davenport.

MR. T. F. HOUSTON, of Albany, inclosed the following under date of October 26th: "Action recently taken by the Schenectady (N. Y.) Gas Light Company seems to indicate that the long-deferred hopes of the city for an improved gas service are to be realized at last. A material reduction is to be made by the Company in the prices heretofore maintained, and the plant is to be put into a condition to improve materially the standard of the gas produced. The price paid by the consumers during the past 10 years has been as high as $3.50 per 1,000 feet, and has never fallen below an average of $2.25. It was claimed, and perhaps correctly, under the old management that no profits accrued to the Company at the latter rate, the fact being explained by the worn-out condition of the plant, and the waste due leaky mains and services. The new management finds that by obtaining improved machinery and laying a considerable length of new mains gas can be furnished at $1.70 per 1,000 cubic feet. Work was undertaken on the 22d of October, preparatory to the erection of a three-story brick building on the site now occupied by the main building on South Center Street. The structure will be considerably larger than the old one, will be three stories high, and will be built without interrupting the operation of the present carbonizing arrangements. A new holder, to be inclosed, will be erected, and new machinery, in fact, will be installed throughout. The main laying which has been going on for some time will be continued until frost stops the work. The most substantial proofs, however, of the Company's intention to conduct its business on a modern basis is found in its announcement to reduce the price of gas from and after November first to $1.70 per 1,000 cubic feet. Schenectady, therefore, will at last be placed in a condition to compare favorably with other cities as regards its facilities for obtaining light."

A RECENT issue of the Connersville (Ind.) *Times* is responsible for the statement that the plant and franchises of the Connersville Gas Light Manufacturing Company will likely pass into other hands, Mr. Huston having offered the property for sale. The Company also controls the local electric lighting enterprise.

THERE is a great demand just now for crude ammoniacal liquor, which commodity is decidedly scarce.

THE new power station for the Nassau Electric Railway Company, of Brooklyn, N. Y., the dimension of which is 100 feet in length, is to be constructed entirely of iron and steel, the whole to be designed and built by the Berlin Iron Bridge Company, of East Berlin, Conn. The roof covering is to be of the Berlin Company's well-known patent anti-condensation, corrugated material. The Berlin Bridge Company will also construct an extension to the muffle room of Messrs. Randolph & Clowes, of Waterbury, Conn.

THE Burlington (Vt.) Gas Light Company is to make a notable addition to its main system and the scheme so far arranged includes extensions on Summit, South Union, Battery and Buell streets.

A DEVELOPMENT in connection with the application of the proprietors of the Kansas City (Mo.) Gas Light and Coke Company to the local authorities for a renewal of their franchise is afforded in the following proposed city ordinance which was offered in Councils by Mr. Tiernan:

*Whereas*, The franchise granted by an act of the Legislature, February 20, 1865, by which the Kansas City Gas Light and Coke Company acquires a monopoly or exclusive right to furnish this city and its inhabitants with gas for a period of 30 years will expire February 20, 1895; and

*Whereas*, A franchise granted any person or corporation for the purpose of supplying gas to this city and its inhabitants for 30 years from the expiration of the present exclusive franchise, will be of great value, and the city should receive a proper consideration for the same; therefore be it ordained by the Common Council of Kansas City:

*Section* 1. That the City Comptroller be and is hereby authorized and directed to receive sealed proposals for a franchise to be granted by the city, for a period of 30 years, for the construction and maintenance of a

system of gas works in the city to supply the city and its inhabitants with gas. The sealed proposals shall state :

(*a*) The maximum price to be charged private consumers and the city for gas and public lamps—the lamp posts and lamps for public lighting to be furnished and maintained by the grantee of the franchise.

(*b*) The amount to be paid to the city for such franchise ; said amount to be a per centum upon the gross earnings of the plant.

(*c*) Within what length of time after the granting of the franchise will the plant be constructed and in operation.

(*d*) A copy of the franchise bid for, or a statement of the substance thereof, shall accompany each proposal.

*Section* 2. The notice for proposals shall be published by the City Comptroller in such newspapers, for a period of not less than 5 days, as he may, with the approval of the Mayor, deem proper. All proposals shall be addressed to the City Comptroller, and by him opened in the presence of the public improvements committees, or a majority of each of said committees, and the result reported to the Common Council.

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Mr. William W. Goodwin sailed for Europe by steamship Westernland from New York on Wednesday last. His son, William Wallace Goodwin, Jr., accompanied him.

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The Lynn (Mass.) Gas Company's new net rate of $1.25 per 1,000 cubic feet is booming gas sales in that thriving Massachusetts center. Mr. Prichard is still in the ring, and means to "stay in it," too.

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The new apparatus for the Hastings (Neb.) Gas Company is about completed.

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The Boston *News Bureau* recently said : "We can state positively that the new management of the Bay State Gas Company is fully decided upon. At the meetings of the several interests which were to have been held on October 25, it was intended to announce the names of the parties in control, and also the names of the committee who will be selected to choose the Board of Managers and President of the several Companies, but owing to minor details necessarily surrounding a deal of such magnitude, the announcement was unavoidably postponed, although it was presumed that the names would be given out prior to November 1st. In addition to President Addicks' resignation we can state that those of Messrs. Dillaway and Fitz have been turned over to the Board and accepted. We can further state that the new head of the Boston Gas Companies will be a man of prominence, and one who has heretofore affiliated with the opposition."

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Mr. E. F. Sherman, Superintendent of the East Portland (Ore.) Gas Light Company, writing to us under date of October 25th, says :

"Dear Journal : I want to correct a statement made in your issue for October 22d. It is stated that the East Portland Gas Light Company will discontinue gas manufacture on the East Side, the supply being drawn from the West Side by means of a main laid under water. What the Company proposes to do, and has already commenced work on, is to carry an 8-inch main on the Burnside street drawbridge, which main is to be of light iron, suspended by hangers from a truss under the footwalk. Connection is made by means of a light iron return bend, sealed by a water lute, which admits of a temporary connection when the holder is to be filled. I returned from Seattle and Tacoma last week, and during my visit I had a pleasant call with Mr. John Mather, of the Seattle Company, who said that the matter printed in the Journal for October 8th, respecting certain suits on promissory notes, and in which Mr. Mather was said to be concerned, was entirely a personal affair, and did not affect the Company in the least. He reports sales of 10,000,000 cubic feet of gas used for fuel during the past year—the fuel gas rate there is $1.50 per 1,000. The Welsbach lamps are in great favor in Seattle. There has been no change as yet in the proprietorship of the Tacoma works. Portland proper reports good gas sales, although the Company has for an opponent an electric lighting company that is operated by water power."

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Application was made some days ago to Justice Cullen, in the Supreme Court, Brooklyn, N. Y., for a writ of mandamus to compel the city of Brooklyn to pay the Kings County Gas and Illuminating Company the sum of $26,500 for gas furnished to the town of New Utrecht, from April 1 to June 30, on public lighting account. Corporation Counsel McDonald opposed the writ and said the bill had been audited by the old Town Board of New Utrecht on June 29, so as to get ahead of the annexation act. Justice Cullen ordered Counsel to submit briefs in the case.

It does not make much difference, we imagine, whether the Company's claims on the public lighting account of the old Town of New Utrecht (it became a part of the city of Brooklyn about midsummer of this year) were audited by the former Town Board or not, for it is agreed by all hands that the Company's contract is valid for the life of the original term thereof, which still has 10 years to run, no matter what may be said of the validity of the amendment that sought to protract the agreement for a term of years beyond 1904. Whether New Utrecht became a part of Brooklyn or not is really foreign to the question, when it comes to the determination of paying its public lighting bills ; for if the Kings County Gas and Illuminating Company faithfully performed its obligations—and the main trouble really seems to be that it has done so both in the spirit and to the letter—the people who are thus served cannot now save their pockets by complaining that they did not know what the cost would be when they put their names to the contract. It is also worthy of note that the New Utrecht reformers, in their zeal to make out a case against the Company for the abrogation of the contract, at first insisted that the rate paid per lamp per annum ($28 per lamp for 4,000 hours of lighting, with 4 ft. burners, lighting and extinguishing included) was exorbitant, but a slight investigation in other nearby districts—in fact, over in the adjoining district of Flatbush—of the cost of public lighting, moved them so they did not insist on this feature of their argument.

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The Toronto *World* says that the question of the right of the authorities of that city to assess the mains of the Consumers' Gas Company will be argued some time this month in the Non-Jury Court, at Osgoode Hall. The city has assessed the gas mains at approximately $500,000, the taxes amounting to nearly $8,000. The company paid the tax under protest, and although Judge McDougall has held that its mains are taxable, the Company in its appeal says the Assessment Act does not so read. Mr. McCarthy, Q. C., will plead the Company's case.

---

The Coney Island gas works was the scene of a slight explosion the other day, but no serious damage resulted. The Company reports a fair share of business for the season of '94.

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The Chicago Gas Stove Company has been incorporated by Messrs. John S. Bindell, William Laemmer and Cyrus Falconer, Jr. It is capitalized in $20,000.

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The special election held at Duluth for the purpose of deciding whether or not the plants of the Duluth (Minn.) Gas and Water Works Company should be purchased for the account of the residents, and to be operated hereafter under municipal control, resulted in the affirmative. The vote was 2,073 for, and 1,876 against.

---

Mr. Charles W. Smith, who is president of the Smith Specialty Company, of Norwalk, Ohio, and who is also a candidate on the "Populist Reform" ticket for the office of Surveyor of Huron County, was arrested, on the complaint of Mr. G. H. Christian, Jr., Superintendent of the Norwalk Gas Light Company, who charged him with having connected the house service with the riser—the meter had been removed from the premises some time previously—by means of a rubber tube, thus securing a supply of gas without having to pay therefor. Smith is evidently a practical populist.

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Last week the Gas Meter Makers' Union conplained to the Central Labor Union of this city that the Equitable Gas Light Company refuses to abide by the weekly payment law, and it was resolved to notify the factory inspector of the district.

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The Otto Gas Engine Company will build an addition to its already extensive factories, corner of 33d and Walnut streets, Phila., Pa.

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Two itinerant meter inspectors (they profess to be able to prove both gas meters and electric ones) named McCauley and Mon have been making trouble for the Peoria (Ill.) Gas Light and Coke Company and the local electric lighting concern as well. The itinerants, however, desisted when informed that they were liable to imprisonment for interfering unwarrantably with the property of the lighting companies.

---

One of the things that the voters of Toledo, O., will be called to pass upon at the election this week is this : "Shall the Toledo Electric Street Railway Company be authorized to do general and public lighting by means of electricity of the streets, lands, lanes, squares, public places and buildings of said city."

THE report of Mr. Andrew J. O'Reilly, Superintendent of the city lighting for St. Louis, Mo., for the fiscal year ended April 9, 1894, shows a decrease of almost $75,000 in the cost of lighting public streets, parks, alleys, etc., over that of 1890, but an increase of $10,000 in the cost of lighting public buildings over that year, the ratio of increase being $2,500 a year. The expenditures for all purposes were $291,769.12, or $37,000 less than the appropriation.

THE Chattanooga (Tenn.) Electric Light Company, which has for some time been in the hands of a receiver, is to be foreclosed under the mortgage on the 22d inst. It is said that the city may attempt to bid it in.

THE proprietors of the Standard Gas and Electric Light Company, of Huntington, L. I., have offered to maintain 115 public gas lamps, to be lighted to 12 o'clock every night in the year, at the rate of $18 per lamp per annum.

ANOTHER point in connection with the attempt of the Kansas City Gas Light and Coke Company to secure a renewal of its franchise is afforded in the following synopsis of an ordinance introduced recently in the City Council by Alderman Huttig, authorizing Messrs. R. M. Snyder, C. J. White, David O. Smart, J. C. James and C. F. Gummey to construct a gas plant and to sell gas for a period of 30 years. The promoters offer to give the city 2 per cent. of the gross proceeds, to furnish gas to private consumers at $1.10 per 1,000 cubic feet, with a reduction of 10 per cent. when bills are paid before the 10th of each month, to bid at any time the city shall demand for the lighting of street lamps, and to give to the city at any time during the life of the franchise the option to buy the plant, the valuation to be fixed by the Circuit Court. The Company agrees to put up $10,000, to be forfeited to the city in the event that it does not expend at least $100,000 the first year after the franchise has been granted to it.

WE are in receipt of a copy of the handsomely illustrated catalogue of its specialties recently published by The Lunkenheimer Company, of Cincinnati, Ohio.

## The Photometry of Diffused Reflection.[1]

By Mr. E. LOMMEL.

In a previous paper "On Fluorescence," I have shown under the heading "The Principles of Photometry,"[2] that in theoretical photometry it is not the surface elements of the luminous surface, but the volume elements of the luminous body which must be regarded as emitting light. Accordingly, the following three propositions were taken as a basis for the theoretical treatment of photometric problems:

1. The quantity of light radiated from one volume element to another is inversely proportional to the square of their distance.

2. The quantity of light emitted from a volume element, and incident upon a surface element, is proportional to the cosine of the angle of incidence.

3. The light radiated by a volume element is enfeebled on its way through the radiating body according to the law of absorption.

Lambert's law of the cosine of the angle of emission was thus eliminated from the set of photometric principles, and its place was taken by the present proposition 3. The cosine law was now obtained as a consequence of the above principles, but only for opaque glowing bodies; for self-luminous bodies transmitting light, such as flames, the cosine law does not hold.

In the work referred to, the behavior of none but self-luminous (incandescent and fluorescent) bodies was taken into account, whereas the much more difficult problem of bodies glowing with borrowed light by diffused reflection was left untouched.

For diffusively reflecting bodies also the cosine law had, since Lambert, been taken as determining the intensity of light reflected by them. This assumption could, however, neither be based upon theory, nor did it appear to correspond with the facts of observation. This state of things has recently been emphasized by Seeliger, with special reference to the photometry of the planets. He showed, by a series of observations, that an experimental corroboration of Lambert's law for diffusing bodies cannot be thought of. *Apropos* of these works of Seeliger, I have resumed the work already begun in 1880, dealing with the task of deducing the behavior of diffusively reflecting bodies from the above-stated principles of photometry.

1. If through the surface $d\omega$ of the volume element $d\omega\, d\rho = dv$ of an illuminating diffusing body, the amount of light $d\omega$ (*i. e.*, unit light per unit of area) penetrates perpendicularly, let $l\, d\omega\, d\rho$ be the amount of light diffused in all directions by the volume element. The quantity $l$ we may call the *diffusive power* of the body. This is independent of the color of the incident light, and only depends upon the degree of dullness, pulverization, disintregration, sponginess, cracked structure, etc., of the diffusing body; for a perfectly pure, limpid body the diffusing power $l$ is zero.

2. Since the beam of light of intensity $d\omega$, in passing through the distance $d\rho$, loses the amount of light $l\, d\omega\, d\rho$ diffused in all directions, it is enfeebled by diffusion according to the same law as holds good in the case of absorption.

3. At the same time it is enfeebled by absorption proper, both in passing through the diffusing particles themselves, and through the transparent medium in the space between them. By this absorption it loses the further quantity

$$k\, d\omega\, dp$$

where the absorptive power $k$ is a function of the wave length, since particles and medium may be colored.

4. The supposition hitherto made, that the volume element is a rectangular prism with its edges parallel to the direction of the incident beam, is not at all necessary. For, whatever may be the shape of the volume element, it may be supposed to be subdivided in a direction parallel to the rays into narrow right prisms, each of which affects the incident light in the manner specified. By a volume element of any shape, therefore, the quantities of light $k\, dv$ and $l\, dv$ are abstracted, by absorption and diffusion respectively, from a beam having unit quantity of light per unit of sectional area.

5. The quantity of light $l\, dv$ is radiated in all directions by the volume element. If we assume that the radiation takes place equally in all directions, then the surface $4\pi$ of a sphere described with unit radius about the volume element is uniformly illuminated by the quantity of light $l\, dv$. The quantity of light, therefore, which the element $dv$ radiates in any direction per unit of area of this sphere is

$$\frac{l}{4\pi} dv$$

* * * For absolutely white bodies (where R=0), the amount of light radiated by a surface element $d\omega$ in all directions, when illuminated by parallel rays at an angle of incidence $i$ is $a\, d\omega \cos i$, where $a$ is the intensity of the incident light. The amount of light radiated by a body equally illuminated from all directions in a direction at an angle $\varepsilon$ to the normal is $a\, d\omega \cos \varepsilon$. We therefore obtain the following propositions:

If an absolutely white body is illuminated by parallel rays from any direction, the amount of light sent out in all directions from its surface (its illuminating power) is proportional to the cosine of the angle of incidence.

If the surface of an absolutely white body is equally illuminated from all directions, the quantity of light radiated by it in any given direction is proportional to the cosine of the angle of emergence.

These propositions, enunciated for absolutely white bodies, also hold in colored bodies, for those colors whose absorption may be taken as indefinitely feeble.

But these two propositions show in what sense, and with what reservations, the cosine law for the angles of incidence and emergence respectively may be taken as valid according to our theory. * * * The intensity of light L radiated in a direction $\varepsilon$, by an opaque diffusing body, when the light is incident vertically, is given by the formula:

$$\frac{4\pi}{a\, d\omega} L = \frac{l}{2\,(k+l)} (P + u\, Q),$$

$$\text{where } P = \frac{2\cos\varepsilon}{\cos\varepsilon + 1}, \text{ and } Q = P\left(\log 2 + \cos\varepsilon \log \frac{1+\cos\varepsilon}{\cos\varepsilon}\right).$$

[$u$ is a constant depending upon the physical constitution of the body].

* * * Of the substances investigated, marble alone approximately follows the cosine law. According to our theory it would only hold in the case of illumination from all directions for a body approaching absolute white. The numbers for papers and cardboard do, indeed, approach the new law more closely than the cosine law; but we cannot speak of even an approximate correspondence. But since these substances are translucent, the formula found for perfectly opaque plates cannot be applied to them; we should have to use the formula applicable to any given thickness of plate. But this would give for a thin sheet the light radiated as being independent of the angles of incidence and emergence. An increase of this amount of light with increasing angle of emergence up to a maximum, as found by observation, cannot be explained on the basis of the new law of emergence, any more than on that of the cosine law.

That the angles of incidence and emergence should be interchangeable, as demanded by Lambert's law as well as the new law, is also contradicted by the numbers obtained for paper and cardboard.

On the other hand, the values found for porclain agree pretty closely with those calculated by the new law, while they diverge considerably from the cosine law. The "albedo" upon which the calulation was based was 0.4, which Lambert takes as the approximate value for white bodies in general. While the divergences from the cosine law amount to 31 per cent., they do not exceed 4 per cent. in the case of the new law.

In the preceding I have also indicated the method for the theoretical treatment of the diffused light passing through a translucent dull body. A closer investigation of this question is reserved for a future communication.

1. Abstract from *Wied. Ann.* Vol. XXXVI., p. 473, 1889.
2. *Wied. Ann.*, Vol. X., pp. 449 and 631, 1880.

## The Market for Gas Securities.

There is nothing much to say in connection with the market for city gas shares, although it is of record that Consolidated sold up to 119 during the week, and to-day (Friday) 118½ is bid for it. Mutual is somewhat easier, and Equitable holds up fairly well. There is an unmistakable hardening tendency in Standard preferred and common, and we look for much higher prices in these shares in the near future. Mr. McMillin resigned from the Presidency of the East River Company, but, as his successor is his partner, the difference is only that between tweedledum and tweedledee. Mr. H. H. Rogers was also elected a Director in the concern. It is said the Company is distributing gas in this city, the chief consumer of the same being its office premises, in 42d st.

Brooklyn shares show no change, and one may look for the news at any moment now that the arrangement for the abatement of competition has been completed. Bay State is a trifle stronger, and Consumers, of Jersey City, is bid for at 62, ex-div. of 3 per cent.

## Gas Stocks.

**Quotations by Geo. W. Close, Broker and Dealer in Gas Stocks.**

16 Wall St., New York City.

November 5.

☞ All communications will receive particular attention.
☞ The following quotations are based on the par value of $100 per share.

| | Capital. | Par. | Bid | Asked |
|---|---|---|---|---|
| Consolidated | $35,430,000 | 100 | 118½ | 119½ |
| Central | 500,000 | 50 | 103 | — |
| " Scrip | 220,000 | — | 100 | -- |
| Equitable | 4,000,000 | 100 | 170 | 175 |
| " Bonds | 1,000,000 | — | 106 | 108 |
| Metropolitan, Bonds | 658,000 | — | 108 | 112 |
| Mutual | 3,500,000 | 100 | 147 | 150 |
| " Bonds | 1,500,000 | — | 100 | 102 |
| Municipal, Bonds | 750,000 | | — | — |
| Northern | | 50 | — | — |
| " Bonds | 150,000 | — | — | 100 |
| Richmond Co., S. I. | 348,650 | 50 | 50 | — |
| " Bonds | 100,000 | — | — | — |
| Standard Gas Co— | | | | |
| Common Stock | 5,000,000 | 100 | 37 | 40 |
| Preferred | 5,000,000 | 100 | 81 | 85 |
| Yonkers | | 50 | 112 | — |
| Gas Co's of Brooklyn. | | | | |
| Brooklyn | 2,000,000 | 25 | 111 | 113 |
| Citizens | 1,200,000 | 20 | 50 | — |
| " S. F. Bonds | 320,000 | 1000 | — | 101 |
| Equity Gas Light Co | 2,000,000 | 100 | — | — |
| Bonds | 1,000,000 | — | — | — |
| Fulton Municipal | 3,000,000 | 100 | 150 | 155 |
| " Bonds | 300,000 | | 103 | — |
| Peoples | 1,000,000 | 10 | 75 | — |
| " Bonds (7's) | 368,000 | — | 100 | — |
| " " (6's) | 94,000 | — | 98 | 100 |
| Metropolitan | 870,000 | 100 | 145 | — |
| " Bonds (5's) | 70,000 | — | — | 155 |
| Nassau | 1,000,000 | 25 | 172 | — |
| " Ctfs | 700,000 | 1000 | 99 | 100 |
| Williamsburgh | 1,000,000 | 50 | 175 | — |
| " Bonds | 1,000,000 | — | 107 | 110 |
| Out of Town Gas Companies. | | | | |
| Bay State Gas Co.— | | | | |
| Stock | 5,000,000 | 50 | 24½ | 24¾ |
| Income Bonds | 2,000,000 | 1000 | 44 | 45 |
| Boston United Gas Co.— | | | | |
| 1st Series S.F. Trust | 7,000,000 | 1000 | 80 | 83 |
| 2d " " " | 3,000,000 | 1000 | 59 | — |
| Buffalo Mutual, N. Y. | 750,000 | 100 | 120 | — |
| " Bonds | 200,000 | 1000 | 95 | 100 |
| Chicago Gas Company. | 25,000,000 | 100 | 74½ | 74¾ |
| Chicago Gas Light. & Coke Co.— | | | | |
| G't'd Gold Bonds | 7,650,000 | 1000 | 81⅛ | 81½ |
| Consumers Gas Light Co., Jersey City | 2,000,000 | 100 | 62 | x |
| Bonds | 600,000 | 1000 | 92 | x |
| Cincinnati G. & C. Co. | 7,000,000 | 100 | 192 | — |
| Consumers Toronto | 1,600,000 | 50 | 184½ | 187 |
| Central, S. F., Cal | | | 90 | 100 |
| Capital, Sacramento, Cal | | | — | 55 |
| Consolidated, Balt. | 11,000,000 | 100 | 68⅛ | 68½ |
| " Bonds | 6,400,000 | | 107 | 107½ |
| Citizens Gas Lt. Co., Rochester, N. Y. | 500,000 | — | 85 | 101 |
| Bonds | 250,000 | | — | — |

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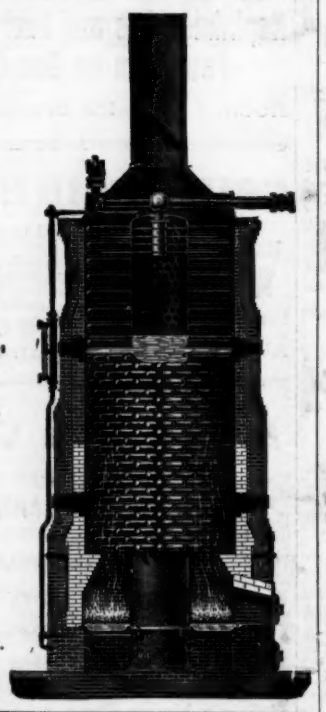
Efficiency, Capacity,
Quality of Steam Produced,
Combustion of Fuel,
Accessibility for Internal and
External Inspection and Cleaning.



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**Cleveland, Ohio.**

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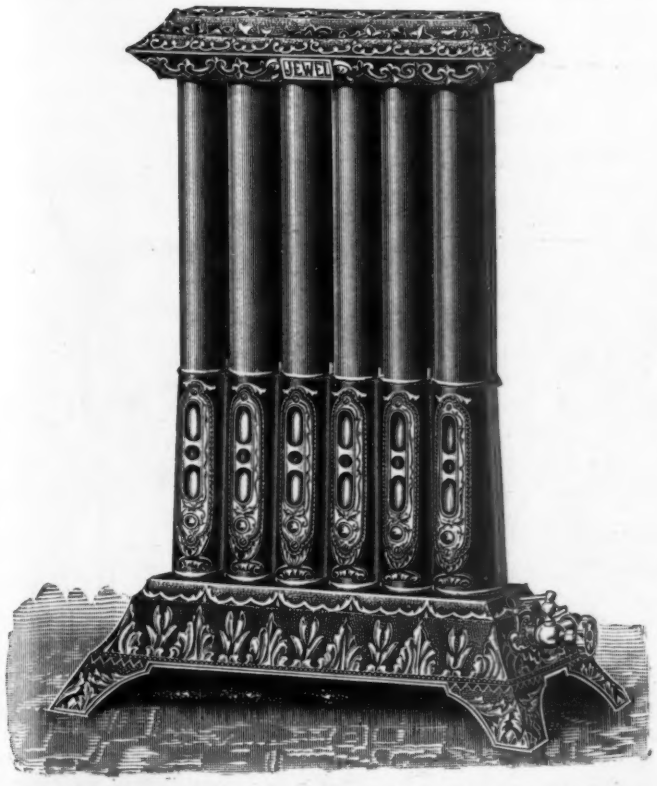


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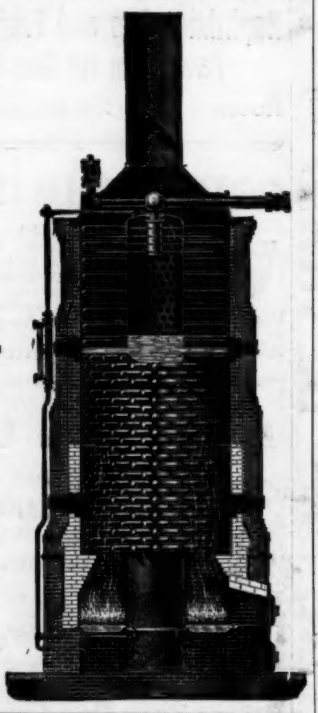

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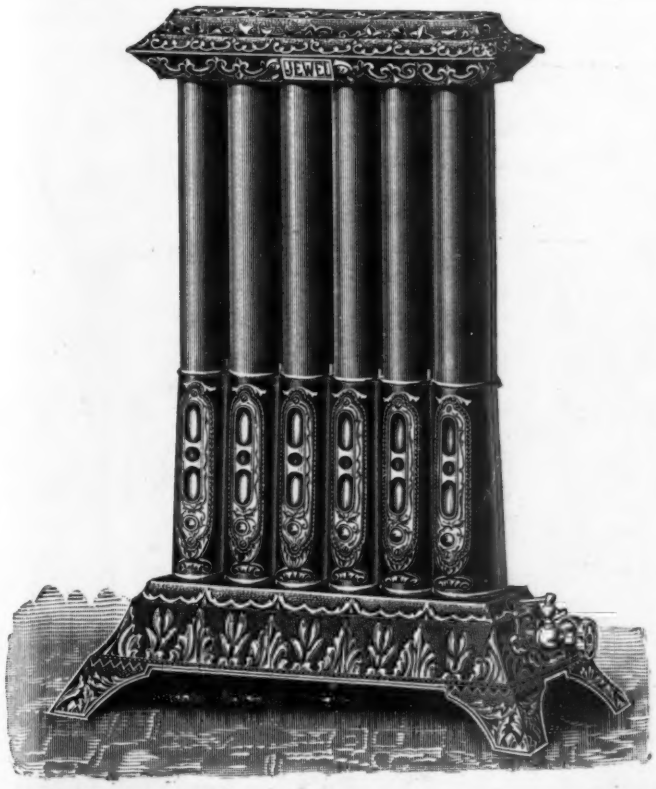


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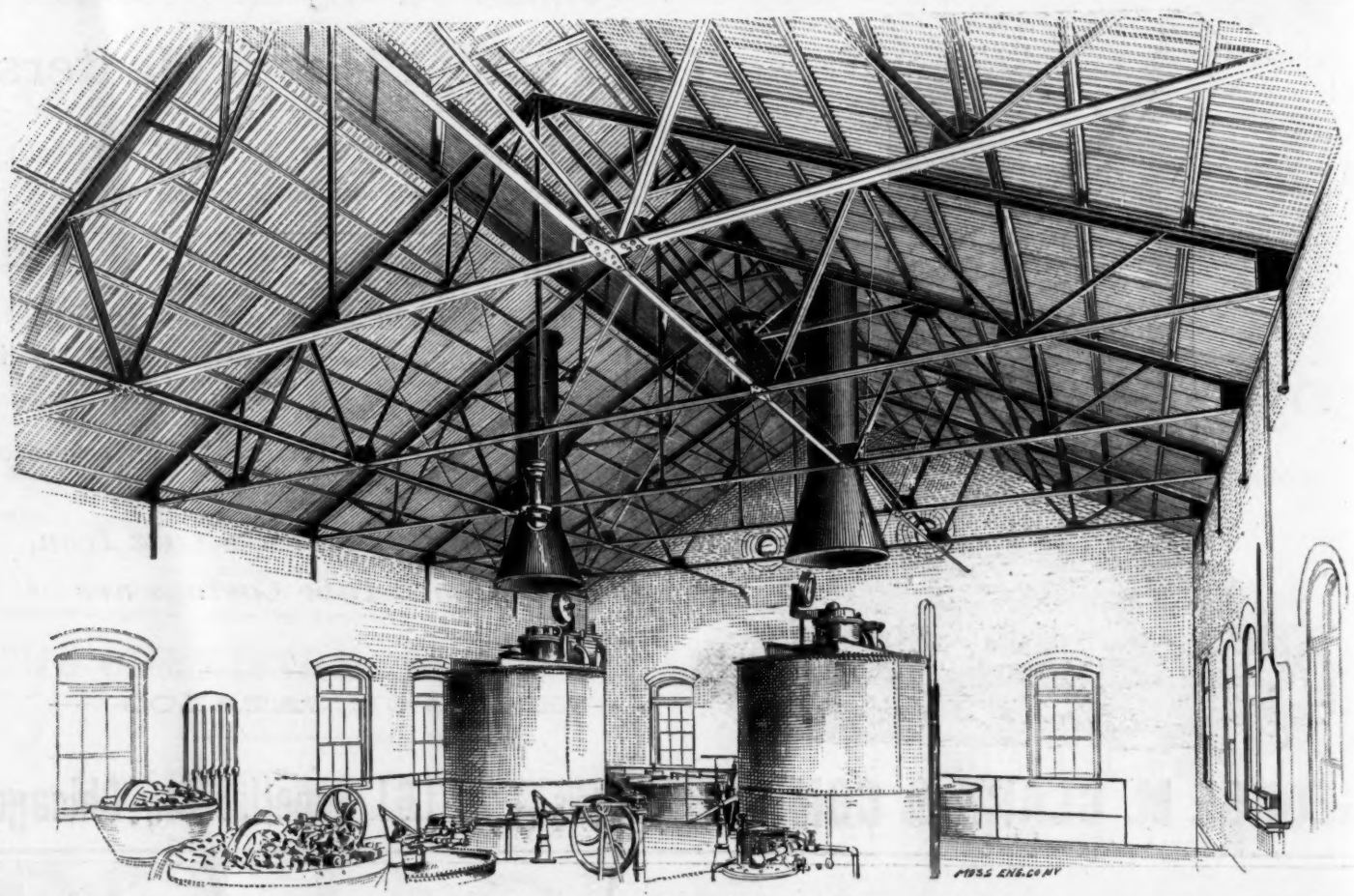

The above illustration is taken direct from a photograph, and shows the construction of an Iron Truss Roof designed and built by us for the Providence Gas Light Company, at Providence, R. I. The building is 40 ft. in width by 100 ft. in length, the side walls being of brick and the roof being entirely of iron—that is, iron trusses and iron purlins covered with corrugated iron. The building is ventilated by our Improved Ventilator, extending the full length of the roof, with side shutters opened and closed by cords from the floor. No woodwork is used in any way about the construction of the building.

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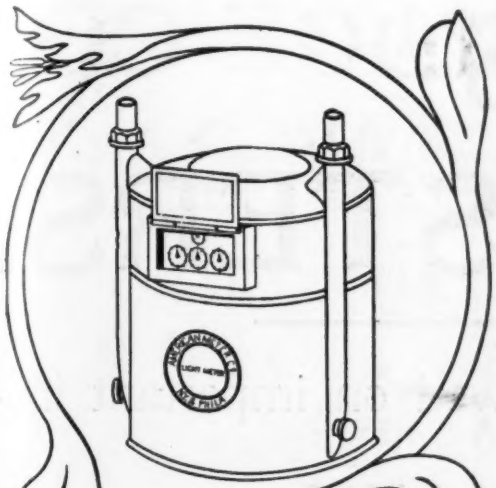

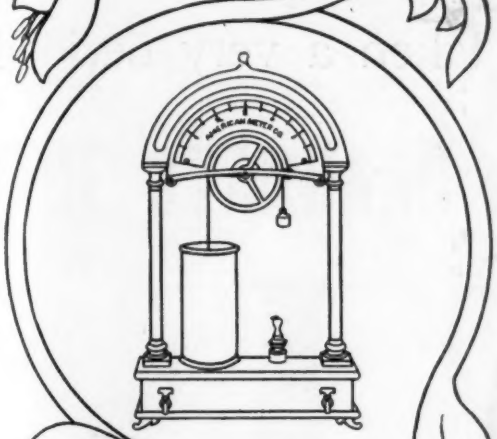

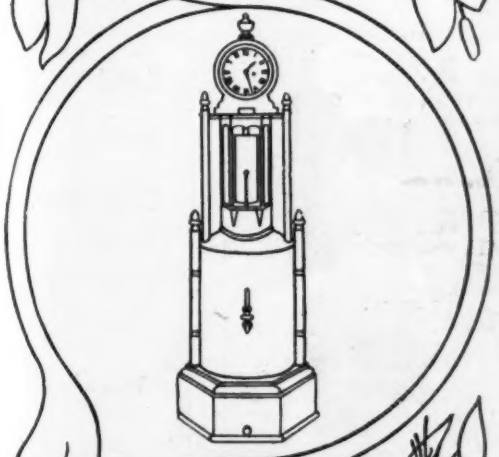

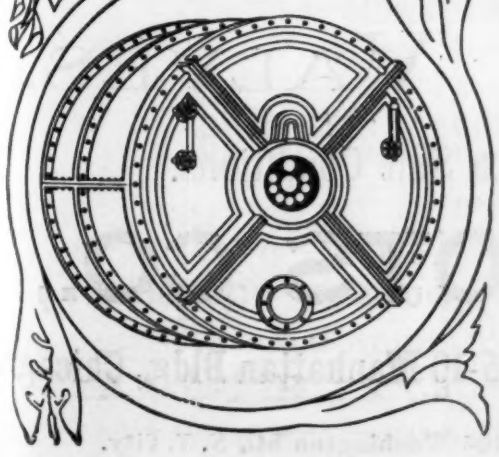

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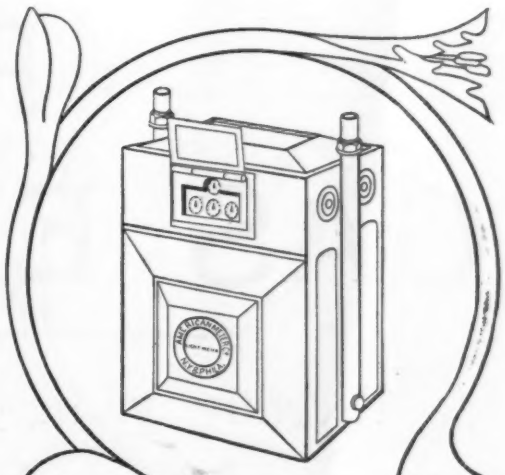
## PUBLIC LIGHTING TABLE.

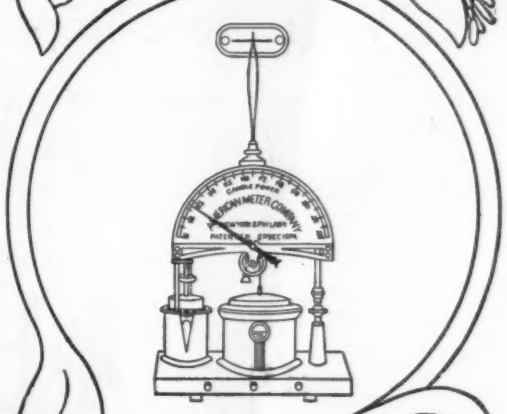
### NOVEMBER, 1894.

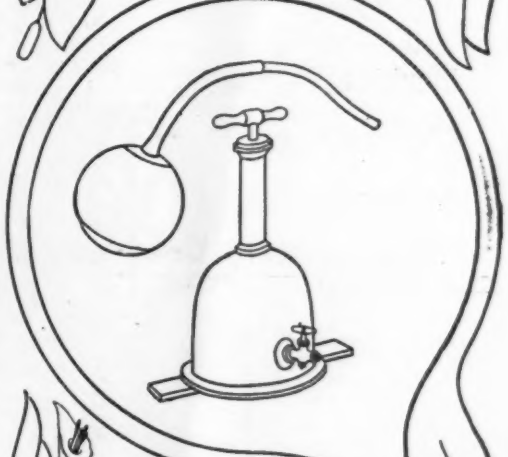
| Day of Week. | Table No. 1. Following the Moon. Date. | Light. | Extinguish. | Table No. 2. New York City. All Night Lighting. Light. | Extinguish. |
|---|---|---|---|---|---|
| | | | | P.M. | A.M. |
| Thu. | 1 | 5.30 PM | 5.30 AM | 4.45 | 5.35 |
| Fri. | 2 | 7.20 | 5.30 | 4.45 | 5.35 |
| Sat. | 3 | 8.20 | 5.30 | 4.45 | 5.35 |
| Sun. | 4 | 9.20 | 5.30 | 4.45 | 5.35 |
| Mon. | 5 | 10.30 FQ | 5.40 | 4.40 | 5.45 |
| Tue. | 6 | 11.30 | 5.40 | 4.40 | 5.45 |
| Wed. | 7 | 12.30 AM | 5.40 | 4.40 | 5.45 |
| Thu. | 8 | 1.30 | 5.40 | 4.40 | 5.45 |
| Fri. | 9 | 2.40 | 5.40 | 4.40 | 5.45 |
| Sat. | 10 | 3.50 | 5.40 | 4.40 | 5.45 |
| Sun. | 11 | No L. | No L. | 4.40 | 5.45 |
| Mon. | 12 | No L. | No L. | 4.30 | 6.00 |
| Tue. | 13 | No L. FM | No L. | 4.30 | 6.00 |
| Wed. | 14 | 5.10 PM | 6.30 PM | 4.30 | 6.00 |
| Thu. | 15 | 5.10 | 7.30 | 4.30 | 6.00 |
| Fri. | 16 | 5.10 | 8.30 | 4.30 | 6.00 |
| Sat. | 17 | 5.10 | 9.50 | 4.30 | 6.00 |
| Sun. | 18 | 5.10 | 11.10 | 4.30 | 6.00 |
| Mon. | 19 | 5.10 LQ | 12.20 AM | 4.25 | 6.00 |
| Tue. | 20 | 5.10 | 1.30 | 4.25 | 6.00 |
| Wed. | 21 | 5.10 | 2.40 | 4.25 | 6.00 |
| Thu. | 22 | 5.10 | 3.50 | 4.25 | 6.00 |
| Fri. | 23 | 5.10 | 5.00 | 4.25 | 6.00 |
| Sat. | 24 | 5.10 | 6.00 | 4.25 | 6.00 |
| Sun. | 25 | 5.10 | 6.00 | 4.25 | 6.00 |
| Mon. | 26 | 5.10 | 6.00 | 4.20 | 6.10 |
| Tue. | 27 | 5.10 NM | 6.00 | 4.20 | 6.10 |
| Wed. | 28 | 5.10 | 6.00 | 4.20 | 6.10 |
| Thu. | 29 | 5.10 | 6.00 | 4.20 | 6.10 |
| Fri. | 30 | 5.10 | 6.00 | 4.20 | 6.10 |

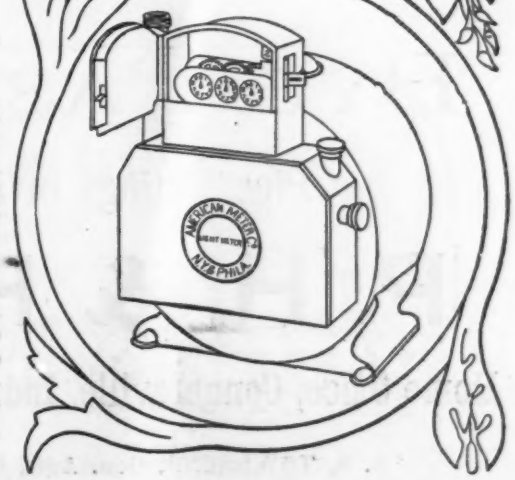
### TOTAL HOURS LIGHTING DURING 1894.

| By Table No. 1. | Hrs. Min. | By Table No. 2. | Hrs. Min. |
|---|---|---|---|
| January | 244.10 | January | 423.20 |
| February | 195.30 | February | 355.25 |
| March | 206.20 | March | 355.35 |
| April | 169.40 | April | 298.50 |
| May | 162.10 | May | 264.50 |
| June | 135.40 | June | 234.25 |
| July | 146.30 | July | 243.45 |
| August | 162.20 | August | 280.25 |
| September | 174.10 | September | 321.15 |
| October | 211.20 | October | 374.30 |
| November | 221.00 | November | 401.40 |
| December | 245.30 | December | 433.45 |
| Total | 2274.20 | Total | 3987.45 |









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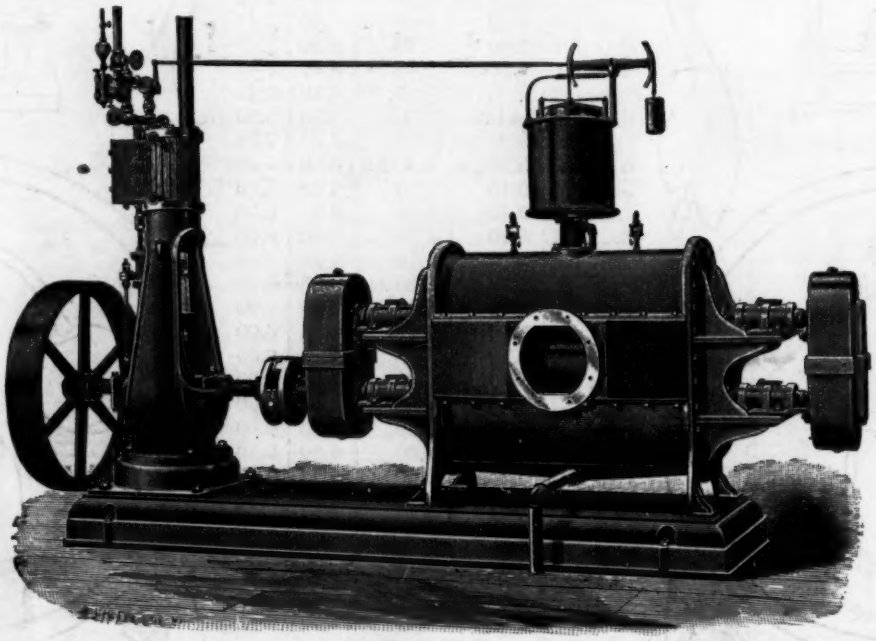

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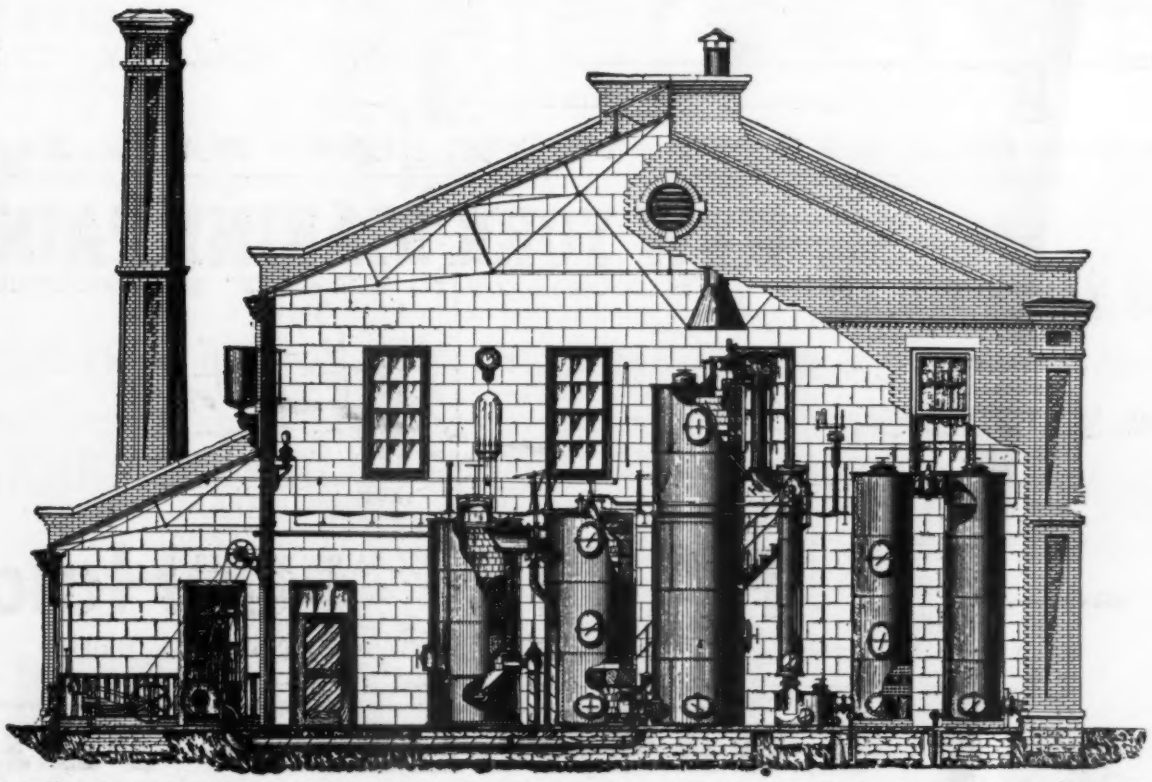

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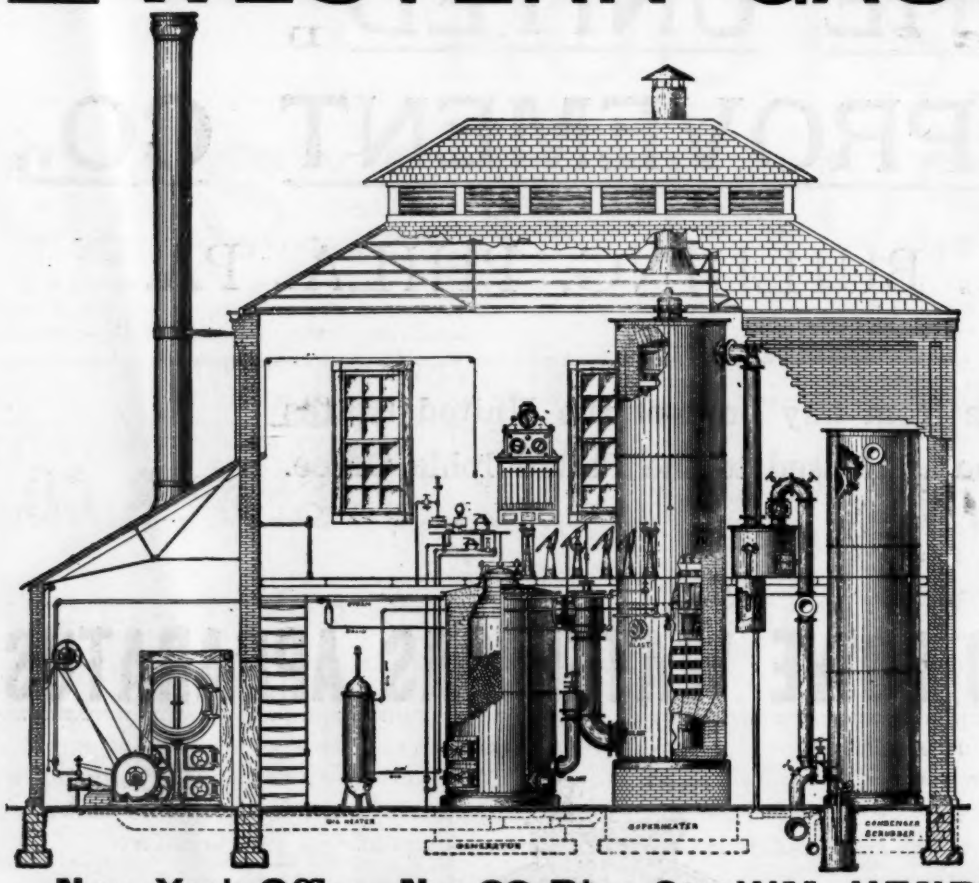

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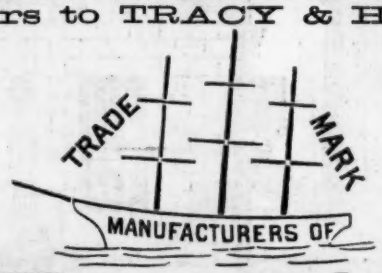


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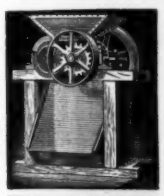

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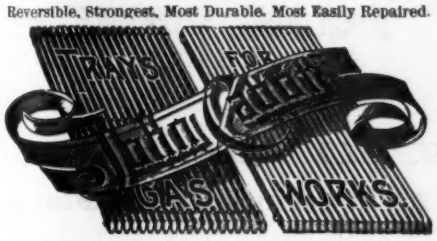


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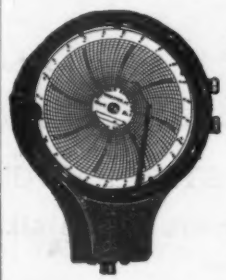

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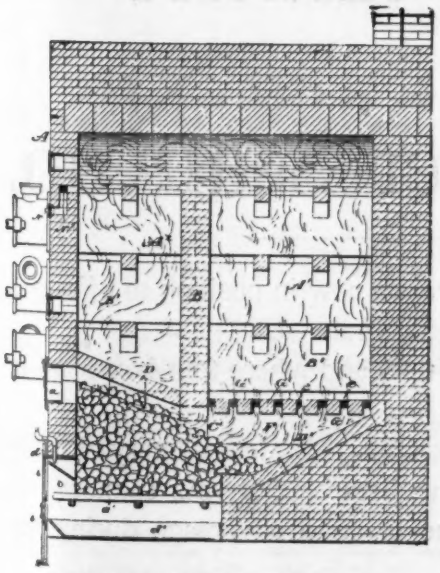

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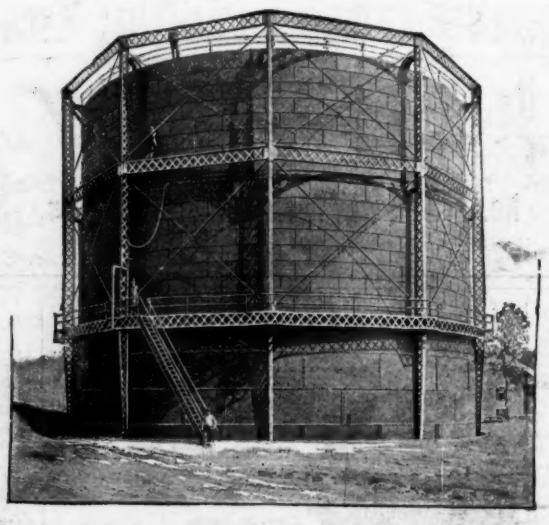

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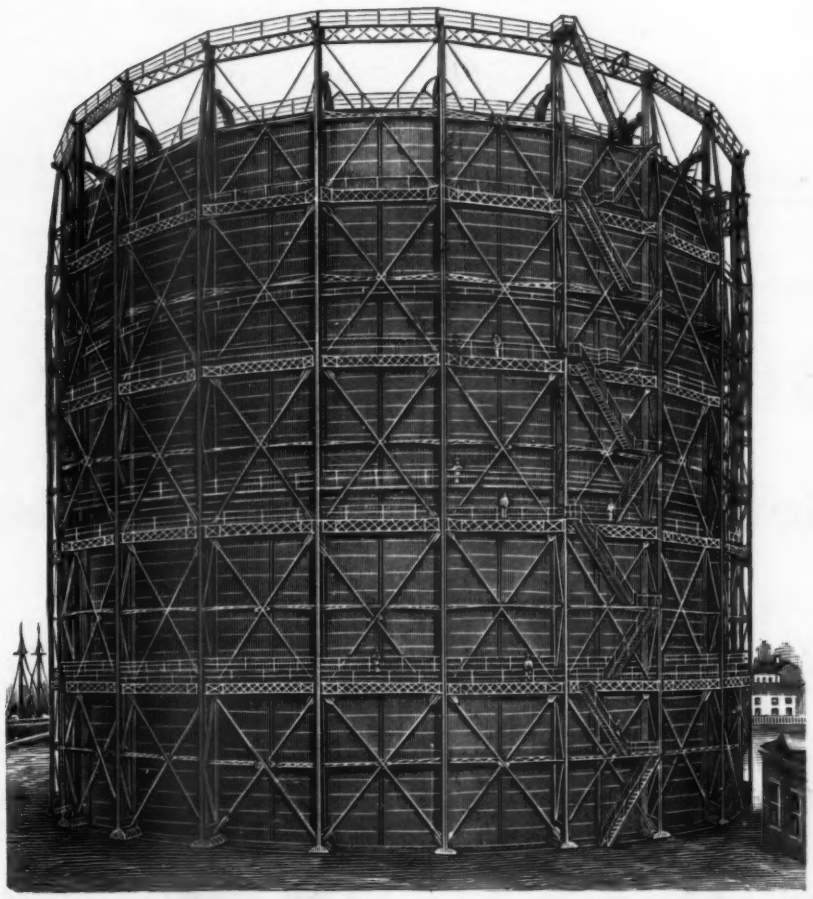

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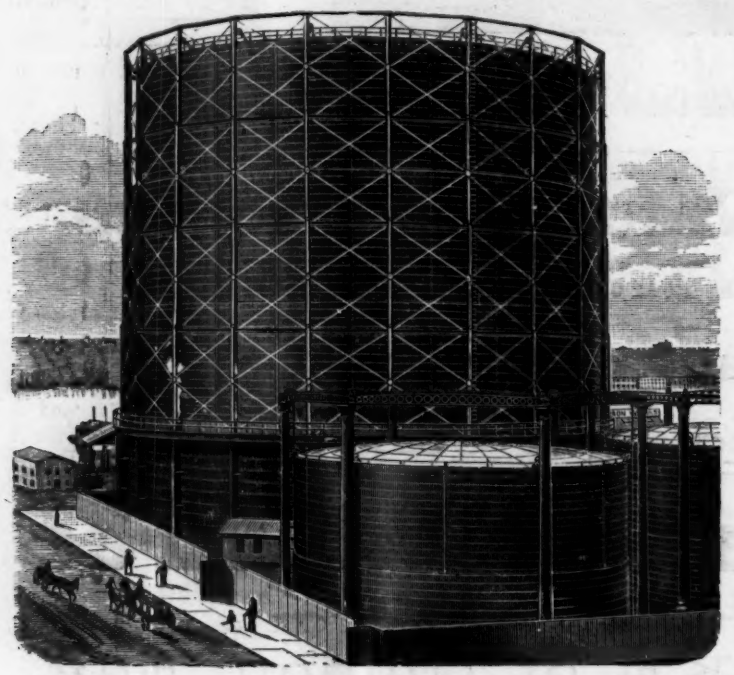

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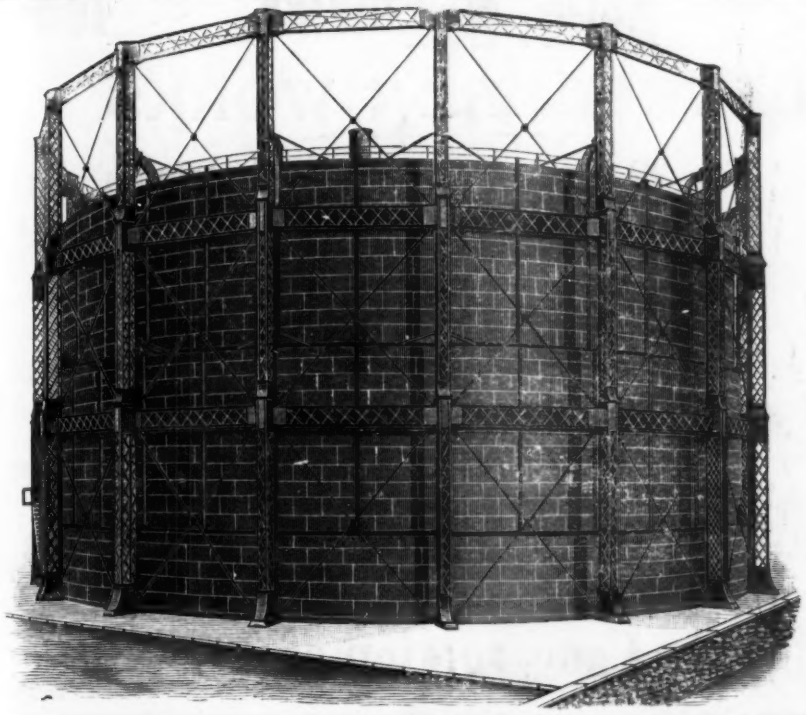

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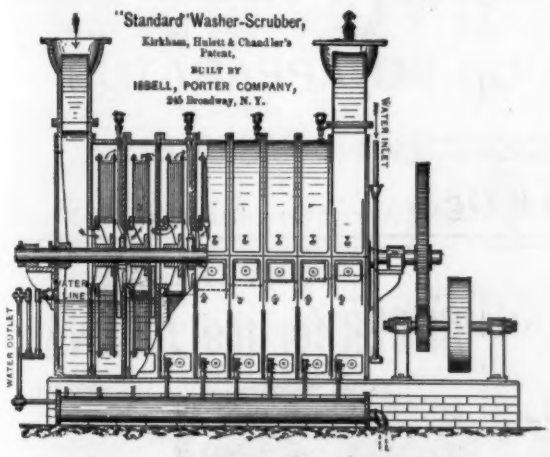


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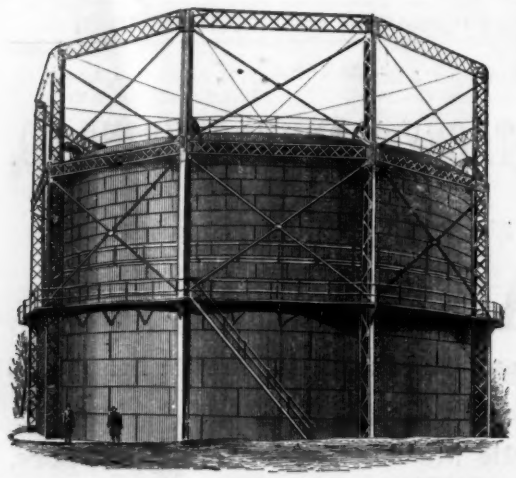

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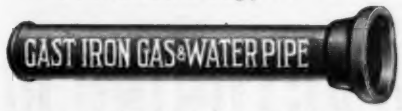


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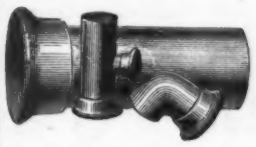

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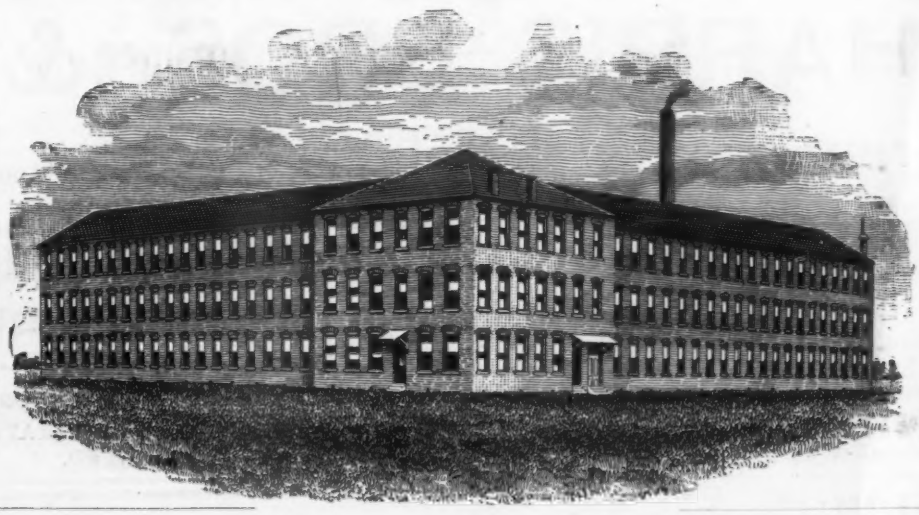

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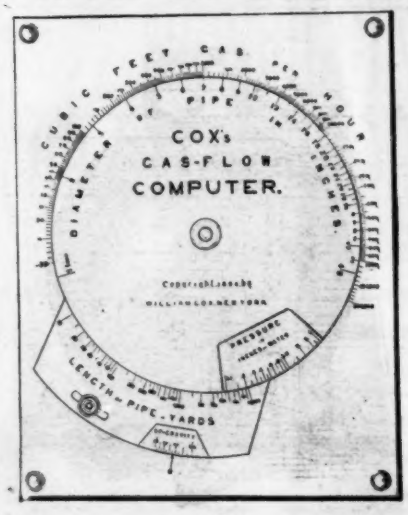


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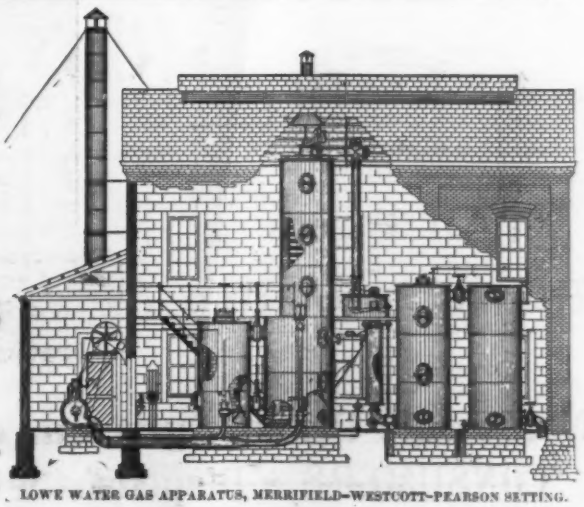

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